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SPECIAL-NEEDS TRANSPORTATION EVALUATION: Service Characteristics and Vehicle Productivity of THE RIDE and the Downtown Distributor

September 1985

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TITLE SPECIAL-NEEDS TRANSPORTATION EVALUATION: SERVICE CHARACTERISTICS AND VEHICLE PRODUCTIVITY OF THE RIDE AND THE DOWNTOWN DISTRIBUTOR

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DATE SEPTEMBER 1985

ABSTRACT The MBTA has provided a door-to-door, many-to-many paratransit service, called THE RIDE, to eligible transportation-handicapped persons since 1977. In March 1982, the MBTA discontinued daytime operation of its many-to-many paratransit service within Boston's downtown or core area, and required that all daytime special-needs trips into, out of, and within the core be made on a new, accessible, fixed-route van service called the Downtown Distributor. This report documents a study that was undertaken to evaluate the operational and efficiency consequences of this change. The evaluation covers various passenger-trip characteristics, vehicle productivity, and the implications of eliminating the Distributor.

This document was prepared by **CENTRAL TRANSPORTATION PLANNING STAFF**, an interagency transportation planning staff created and directed by the Metropolitan Planning Organization, consisting of the member agencies.

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SUMMARY

Since 1977, the MBTA has provided THE RIDE, a door-to-door, many-to-many paratransit service for transportation-handicapped persons, in Boston and nearby communities. Beginning in March 1982, all users making trips into, out of, and within the downtown or "core" area were required to use the Downtown Distributor for the core portion of such trips. The Distributor operated as a fixed-route van service along two routes.

This study was undertaken primarily to assess the operational and efficiency changes precipitated by the Distributor. This assessment was performed by statistically analyzing passenger-trip data from all passenger-trips scheduled during one week in September in 1981, 1982, and 1983.

Some of the study's most salient findings are the following:

- The Distributor's implementation precipitated some changes in the pattern of trip-making. Trips executed with either an origin or a destination in the core--i.e., most of the trips affected by the Distributor--declined as a percentage of all trips from 34% in 1981 to 25% in 1983. Concurrently, trips whose origin and destination lay outside the core--and were, thus, unaffected by the Distributor--increased from 61% to 70%.

- Between 1981 and 1983, most travel times were unchanged. However, travel times for trips between the core and outlying areas--most of the trips directly affected by the Distributor --increased by roughly 100%, from 30 to 64 minutes. This increase included a 15-minute out-of-vehicle wait time necessitated by the transfer requirement.

- Contrary to conventional wisdom, the MBTA's paratransit service demonstrates strong peaking characteristics. Peak demand occurs between 7:00 and 8:00 A.M. and again between 3:00 and 5:00 P.M.

- Forty to forty-five percent of all trips were undertaken for employment purposes, although only 15% of surveyed users claimed to be employed either full- or part-time. Thus, THE RIDE appeared to be heavily used for commuting by employed users. Roughly 20% of trips were for medical purposes, and another 20% for social purposes. Ten percent of trips were education-related. Most trips appeared to be home-based trips.

- Fifty-five to sixty percent of all completed trips were begun at their scheduled time. The MBTA considers all trips begun within ten minutes, plus or minus, of the scheduled pick-up time to be "on time." By this criterion, 85% of all completed trips were begun on time.

- One rationale for creating the Distributor was the belief that it would improve system efficiency by limiting the number of vehicles operating within the congested core area. However, vehicle productivity--one measure of service efficiency--was basically unchanged by the Distributor's implementation.

- The Distributor was designed to operate as a conventional fixed-route bus service. However, users usually made advance reservations by phone for the service, using it in much the same way as they did THE RIDE.

- If the Distributor were eliminated,* there might be a loss of about 5 passenger-trips per day, which would not significantly affect overall vehicle productivity. Thus, it is unlikely that system efficiency would be changed by elimination of Distributor service.

---

*Downtown Distributor service was, in fact, discontinued in May 1985, when this report was in draft form.

1 INTRODUCTION

The MBTA instituted THE RIDE in 1977. THE RIDE was designed to provide door-to-door, "many-to-many" paratransit service in the Boston area. Many-to-many service carries patrons from any point to any other point within a service area. The eligibility requirements are that the patron reside in the service area and that it be impossible or extremely difficult for the patron to use conventional public transportation. Eligible persons must register with the MBTA before using the service.

Between 1977 and January 1983 the geographic area served by THE RIDE was increased, incrementally, by about 100 percent. Further considerable expansion of the service area took place, in stages, during the remainder of 1983. The service area as of January 1983 and as of the end of 1983 is shown in Figure 1-1.

The number and deployment of RIDE vans, and other aspects of service also changed over time. Typical weekday service in 1981 will be used as the base-line service in this study. In 1981, weekday service was delivered by a maximum of 18 vans. Fifteen operated in the morning, making their first pick-ups at 7:00 A.M., and in the early afternoon. At 3:00 P.M., 3 more vans--those vehicles used for evening service--joined the 15 already operating. The 15 vehicles providing daytime service ended their tours at approximately 6:00 P.M. The 3 evening-service vans operated between 6:00 and 11:00 P.M. This general pattern of service delivery remained basically the same between 1981 and 1983.

During March 1982, the MBTA changed RIDE service within the downtown Boston area. THE RIDE was replaced by the Downtown Distributor (hereafter referred to as the Distributor) within the area indicated in Figure 1-2. This replacement service provided fixed-route, lift-equipped van service along two loop routes within the downtown area, during daytime hours only. Travel into and out of downtown Boston required transferring between THE RIDE and the Distributor. The transfer points were Massachusetts General Hospital and South Station. Distributor riders not transferring from THE RIDE could board or alight at any point along the fixed routes (there were no regular stops aside from the transfer points).

The eligibility and registration requirements for the Distributor were the same as those for THE RIDE, with one exception. There was no residency requirement for Distributor users. Thus, there may have been Distributor users who, ineligible for THE RIDE due

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SERVICE AREA OF THE RIDE

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FIGURE 1-1

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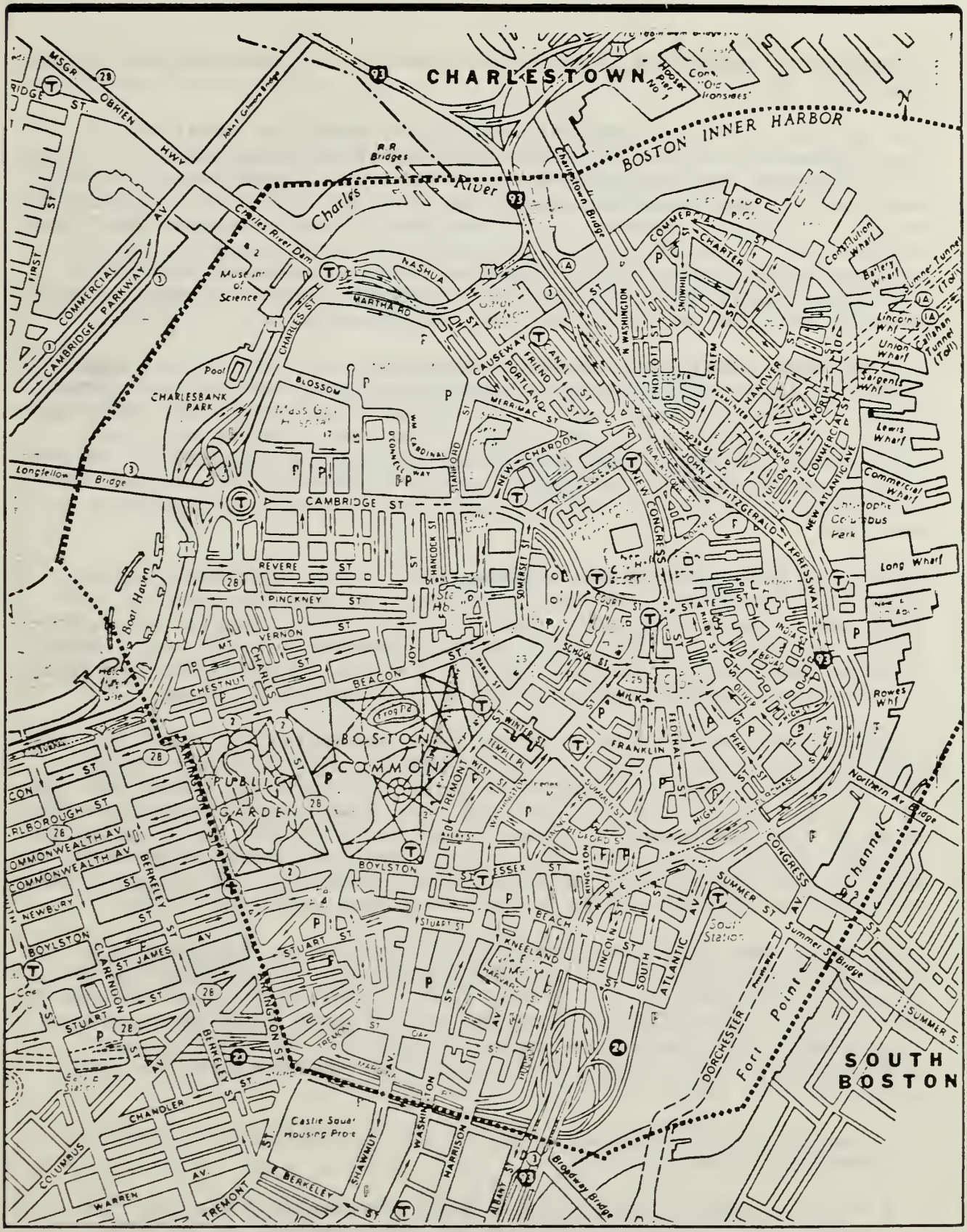

SERVICE AREA OF
THE DOWNTOWN DISTRIBUTOR

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FIGURE
1-2

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to place of residence, made their own way to the downtown to use the Distributor.

The number of vans in operation changed with the start of Distributor service. Whereas in 1981, 18 vans had been available for afternoon peak-period service, in 1982, there were 17 vans available. Fourteen vans operated service during the morning and early afternoon. However, of these 14, 2 vehicles were dedicated to Downtown Distributor service through the afternoon. Between 3:00 and 6:00 P.M., these vehicles were joined by 3 more RIDE vehicles, creating an afternoon-peak RIDE fleet of 15 vehicles. Evening service was provided by 3 vehicles.

As THE RIDE service area was expanded during 1983, three additional daytime vehicles were added to help serve the increased demand. Thus, 15 vans provided RIDE service during the morning hours. Two other vans continued to be dedicated to daytime Distributor service. An additional van began its tour at 1:00 P.M., and two more at 3:00 P.M., creating an afternoon-peak RIDE fleet of 18 vehicles. Evening service was still provided by 3 vehicles.

After the Distributor was implemented, users expressed concern that the Distributor was not providing as much service as THE RIDE had. Users also felt that the Distributor was a less efficient service than THE RIDE. While downtown service was thought to have been most affected, overall service quality was thought to have been affected as well by the diversion of vans.

Distributor service has recently been curtailed to the A.M.- and P.M.-peak periods. Users have suggested that the service be redesigned, if not eliminated altogether. Service users and the service provider have not been able to reach an agreement on what kind of special-needs transportation services are most appropriate for downtown Boston. The debate has been carried on with very little empirical data available concerning the quantity or the quality of the services that have been provided so far.

This study was undertaken to provide such data, and has four principal objectives: to evaluate the service provided by the Downtown Distributor, to assess the systemwide changes wrought by the start of Distributor service, to evaluate RIDE service, and to estimate the operational implications of eliminating the Distributor. The first three objectives are realized through analyzing the following:

- Passenger-trip characteristics of the Downtown Distributor and THE RIDE
- Vehicle productivity of THE RIDE and the Distributor, as measured by passenger-trips per vehicle-hour of service
- In-service operation of the Downtown Distributor

The fourth objective is addressed using the information gathered in addressing the first three.

This report is organized as follows. Chapter 2 addresses the method of study. It describes the data which were collected and explains the rationale for selecting these specific data. In addition, it sets out the parameters for differentiating among four types of passenger-trips.

In Chapters 3, 4, and 5, the three service characteristics listed above are analyzed. The methods, as well as the findings, of each analysis are presented.

Chapter 6 speaks to the issue of eliminating the Distributor; it attempts to project the operational and system-efficiency effects of discontinuing the service.

Chapter 7 summarizes the study's most salient findings and presents recommendations aimed at improving service delivery.

2 DATA SELECTION

The passenger-trip data used in most of the analysis represent all passenger-trips scheduled during one week each in September 1981, September 1982, and September 1983. Selected analyses were performed using all passenger-trips scheduled during one week in September 1984.

Four primary considerations guided the selection of these samples for analysis. First, operating characteristics vary from month to month; these fluctuations are largely attributable to weather changes and other seasonal factors. By selecting data from the same month each year, it was thought that much of the seasonal variation would be avoided.

Second, any significant service change, such as the initiation of the Distributor, upsets a system's normal operating characteristics. The sample month was chosen so as to allow the 1982 data to be from a period six months after the Distributor went into service. It was thought that the system would have come to a new operating equilibrium by that time.

Third, comparison of 1981 and 1982 passenger-trip characteristics was considered to be an effective method for measuring the changes resulting from implementation of the Distributor, since no other significant service changes occurred during this period.

Fourth, a comparison between 1982 and 1983 passenger-trip characteristics was considered important, as it would reflect changes wrought by expansion of THE RIDE's service area.

The data were drawn from the driver's copy of the daily passenger log. An example of a typical passenger log is presented in Appendix A. Passenger logs were typically kept on a vehicle-by-vehicle basis, presenting in chronological order the data on each passenger-trip made by each vehicle on a given day. Drivers were responsible for recording actual trip mileage and trip times for each passenger-trip. Drivers recorded any out-of-the-ordinary trip characteristics under "Remarks."

For this study, data on each scheduled passenger-trip were coded into machine-readable form. These data were then sorted, partitioned, and statistically analyzed using a standard statistical software package, Statistical Analysis System (SAS).

To assess the Distributor's differential effects on downtown and non-downtown trips, a four-part partition of all passenger-trips

To assess the Distributor's differential effects on downtown and non-downtown trips, a four-part partition of all passenger-trips was created. The parameters which defined each trip class are stated below:

Class 1 Core-core trips. Trips with both origin and destination within the downtown area and which involve no vehicle transfer.

Class 2 Linked core-periphery trips. Trips between the downtown and outlying areas which require a vehicle transfer.

Class 3 Direct core-periphery trips. Trips between the downtown and outlying areas, made directly between origin and destination.

Class 4 Periphery-periphery trips. Trips with both origin and destination outside the downtown area--always direct trips, i.e., involving no vehicle transfer.

3 PASSENGER-TRIP CHARACTERISTICS

The following passenger-trip characteristics were evaluated:

- Trip-making patterns by origin-destination characteristics
- Time of travel
- Purpose of travel
- Passenger wait time
- Trip distance
- Trip time

The evaluations included comparison of the characteristics before and after initiation of the Distributor.

In the following sections, each of the characteristics is addressed in turn. The method of study used in the particular analysis is described, after which the major findings are reported.

3.1 DISTRIBUTION OF SCHEDULED PASSENGER-TRIPS BY ORIGIN-DESTINATION CHARACTERISTICS

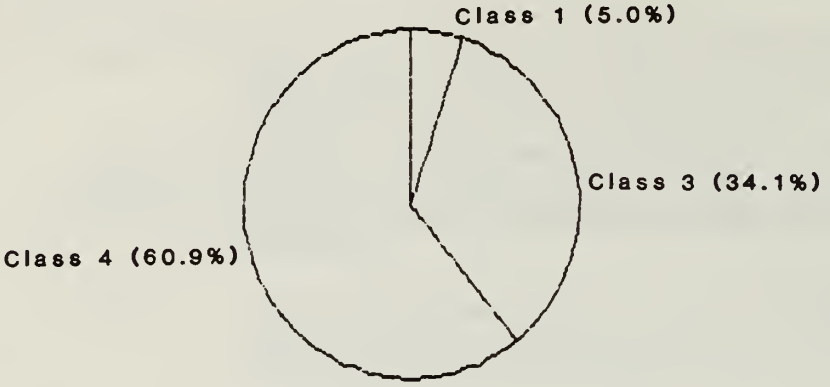
To assess the effects of the Distributor's implementation, all passenger-trip records were partitioned by origin-destination characteristics into the four trip classes defined at the end of Chapter 2. The distribution of trips by trip class was calculated through a simple sorting procedure. Each year's sample data was considered separately.

It should be noted that the 1981 distribution does not include Class 2 trips, because the Distributor had not been implemented. In 1982 and 1983, the vehicle transfer when entering or leaving the downtown--a transfer necessitated in many cases by the Distributor's implementation--distinguishes Class 2 trips from Class 3 trips. One may directly compare 1981 core-periphery (Class 3) trips with the sum of linked (Class 2) and direct (Class 3) core-periphery trips in 1982 and 1983.

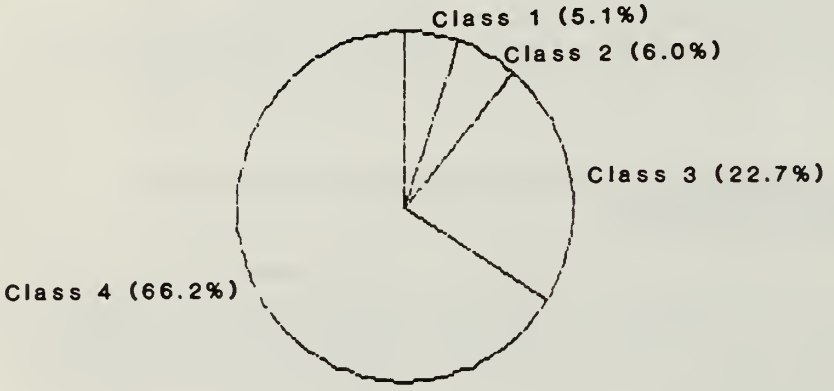
The distributions of scheduled passenger-trips by trip class in September 1981, September 1982, and September 1983 are presented in Figure 3-1 and Table 3-1.

The data suggest that in the 1981-1983 period there was a significant re-alignment in the distribution of scheduled trips: the proportion of periphery-periphery trips increased, while that of core-periphery trips decreased.

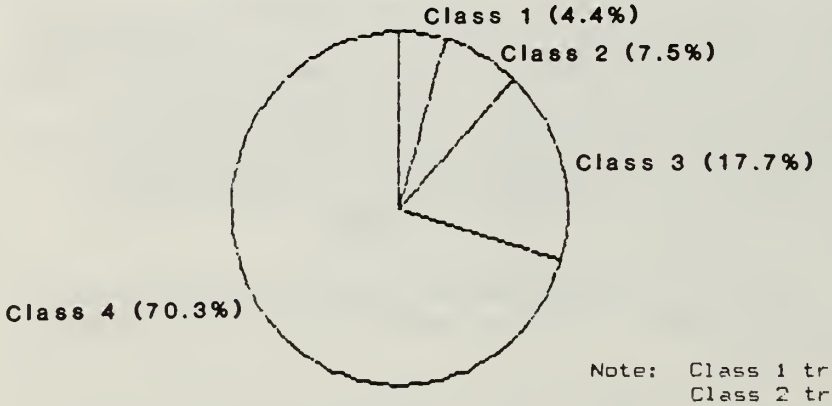
SEPTEMBER 1981



SEPTEMBER 1982



SEPTEMBER 1983



Note: Class 1 trips are core-core
Class 2 trips are linked core-periphery
Class 3 trips are direct core-periphery
Class 4 trips are periphery-periphery

Special-Needs Transportation Evaluation Technical Report 53a September 1985	ADJUSTED DISTRIBUTION OF TRIPS BY ORIGIN-DESTINATION CLASS	CTPS FIGURE 3-1

Class	1981	1982	1983
1	101	95	95
(%)	5.0	5.1	4.4
2	0	112	163
(%)	0.0	6.0	7.5
3*	688	422	383
(%)	34.1	22.7	17.7
4	1229	1233	1520
(%)	60.9	66.2	70.3
TOTAL	2018	1862	2161

* Class 3 trips have been adjusted to eliminate the double counting of Class 2 trips.

Note: Class 1 trips are core-core
Class 2 trips are linked core-periphery
Class 3 trips are direct core-periphery
Class 4 trips are periphery-periphery

Special-Needs Transportation Evaluation	ADJUSTED DISTRIBUTION OF TRIPS BY ORIGIN-DESTINATION CLASS	CTPS
Technical Report 53a September 1985		TABLE 3-1

Between 1981 and 1982 the total number of trips in the sample data declined from 2,020 to 1,860. Core-core trips declined slightly in this interval, core-periphery trips fell from 690 to 530, and the number of periphery-periphery trips remained basically the same. In percentage terms, there was a decline in core-periphery trips, from 34% to 29%, an increase in periphery-periphery trips, from 61% to 66%, and virtually no change in core-core trips.

In the 1982-1983 interval the number of sample trips increased by 16%, from 1,860 to 2,160. The number of core-core trips remained unchanged; as a percentage of all sample trips, they declined about 1%. Core-periphery trips rose in number by 4%, from 530 to 550, but declined as a percentage of all trips from 29% to 25%. Periphery-periphery trips rose in number from 1,230 to 1,520 trips, and increased as a percentage of all trips from 66% to 70%.

The data show that in the 1981-1982 interval--when a general decline in service available and the start of the Distributor were the only significant service changes to occur--core-periphery trips declined relative to periphery-periphery trips. This development suggests that the Distributor's implementation benefited users who lived and could function completely outside the core area, and that users who needed to travel between the core and the periphery bore disproportionately the disadvantages of the service change.

In the 1982-1983 interval, the service area increased; the absolute number of passenger-trips scheduled also increased. Core-periphery trips--trips directly affected by the Distributor--did not increase as rapidly as periphery-periphery trips--trips not affected by the Distributor. In fact, between 1982 and 1983, linked and direct core-periphery trips contined to decline as a percentage of all trips, while periphery-periphery trips continued to increase.

It might be argued that because the service-area additions between 1982 and 1983 increased only the amount of periphery area, these additions were the cause of the disproportionate increase in the number and the percentage of 1983 periphery-periphery (Class 4) trips, relative to all other trip classes. If this were true, the distribution of trips for users living in the new parts of the service area would be skewed toward a disproportionately high percentage of Class 4 trips.

Unfortunately, the 1983 data do not permit a test of this hypothesis. However, the 1984 data do permit such a test; they are presented in Table 3-2. The distribution of 1984 trips by origin-destination characteristics is basically the same for users living in the new and the old parts of the service area. Therefore, if it is assumed that the 1984 data function as a good surrogate for the 1983 data, the 1983 systemwide shift toward an

TRIPS BY USERS RESIDING IN ORIGINAL (1977-1982) SERVICE AREA

Class		No. of Trips	% of All
1	Core-Core	157	3.9
2	Linked Core-Periphery	92	2.3
3	Direct Core-Periphery	932	23.4
4	Periphery-Periphery	2797	70.3
		3978	

TRIPS BY USERS RESIDING IN PARTS OF SERVICE AREA ADDED IN 1983

Class		No. of Trips	% of All
1	Core-Core	7	0.5
2	Linked Core-Periphery	45	3.4
3	Direct Core-Periphery	356	26.6
4	Periphery-Periphery	928	69.5
		1336	

Special-Needs Transportation Evaluation Technical Report 53a September 1985	DISTRIBUTION OF 1984 TRIPS BY ORIGIN-DESTINATION CLASS FOR USERS LIVING IN THE ORIGINAL AND THE NEW PARTS OF THE SERVICE AREA	CTPS TABLE 3-2

increasing proportion of periphery-periphery trips cannot be explained by the expansion of the service area.

In conclusion, the data suggest that, in 1983, users functioning completely in the non-core areas continued to benefit from, and users needing to travel between the core and the periphery continued to bear disproportionately the disadvantages of, the Downtown Distributor.

This section has analyzed changes in the distribution of passenger-trips based on examination of the sample data described at the beginning of this chapter. An analysis of distributional changes based on monthly ridership data was also performed. The conclusions reached in the latter analysis parallel those presented above. Monthly ridership changes are discussed in Appendix C.

3.2 DISTRIBUTION OF SCHEDULED PASSENGER-TRIPS BY TIME OF TRAVEL

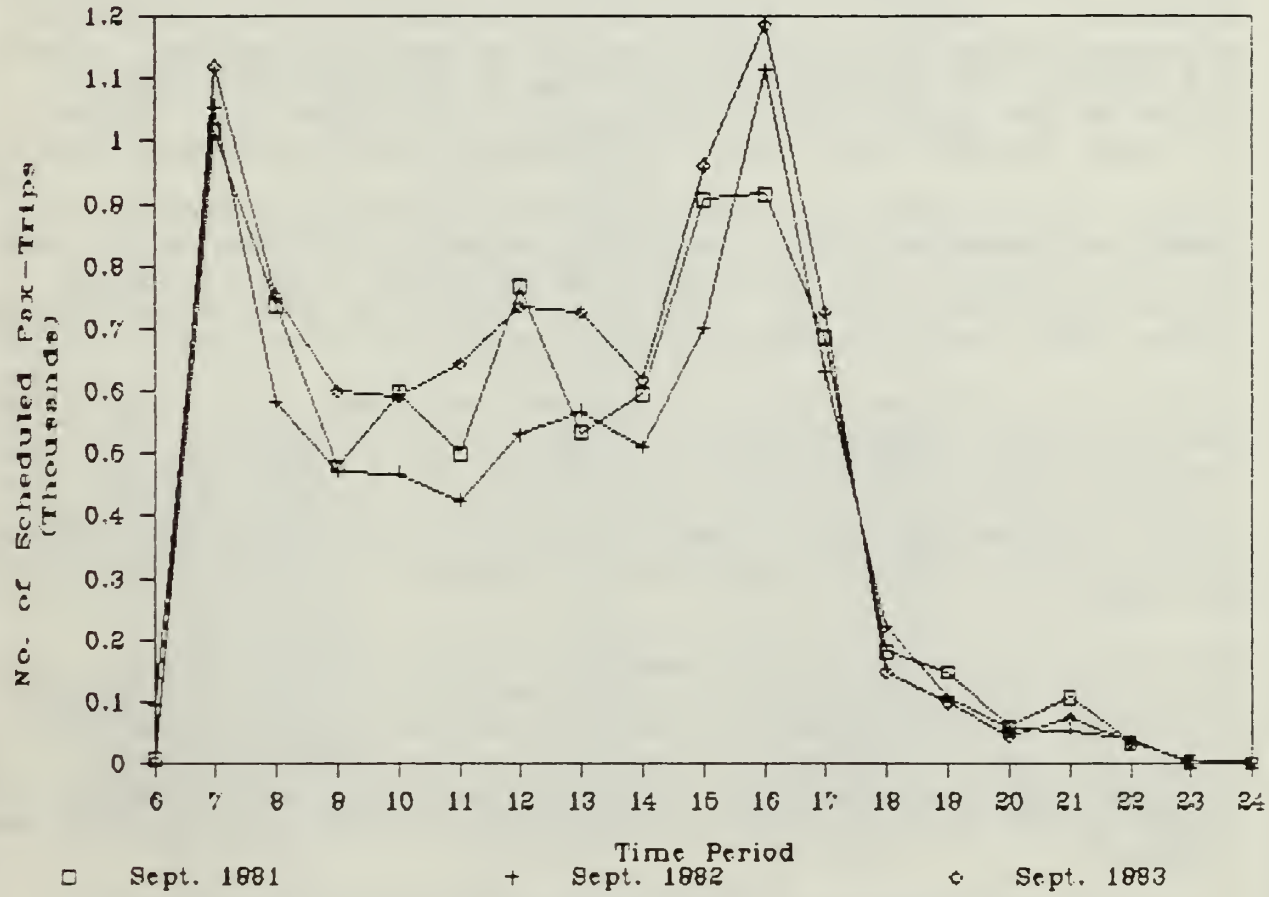
Within each trip class, passenger-trips were sorted both by their scheduled pick-up time and by period of the day. Pick-up time was analyzed in one-hour increments from 6:00 A.M. to midnight. The periods of the day among which the trips were sorted were A.M. peak, daytime off-peak, P.M. peak, and evening, defined as follows:

A.M. Peak	7:00 A.M. to 9:29 A.M.
Off-Peak	9:30 A.M. to 3:29 P.M.
P.M. Peak	3:30 P.M. to 5:59 P.M.
Evening	6:00 P.M. to 12:00 A.M.

Both temporal distributions were calculated for the 1981, 1982, and 1983 sample data. It should be noted that the distributions were factored. The distribution for the sample week from each year was assumed to be representative of the month from which the sample was drawn. Thus, if 5% of the 1982 sample trips (taken from a week in September) occurred between 7:00 and 8:00 A.M., 5% of the 7,193 trips scheduled during September 1982 were attributed to this time period. This procedure was used to factor trips into both the one-hour increments and the four periods of the day. Each monthly distribution was calculated by factoring up the number of trips per time period so that the total number of trips equalled the value given in the MBTA's monthly reports.

The distribution by hour of pick-up of all scheduled passenger trips for September 1981, September 1982, and September 1983 is shown in Figure 3-2. The data from which this graph was derived are presented in Table B-1 of Appendix B.

These distributions indicate that between 1981 and 1982, daytime off-peak travel declined more precipitously than peak-hour travel. Between 1982 and 1983, daytime, off-peak travel increased more resoundingly than did peak-hour travel. Between



Special-Needs Transportation Evaluation Technical Report 53a September 1985	FACTORED TRIP DISTRIB BY TIME OF DAY (Factored from All Scheduled Trips)	CTPS FIGURE 3-2

1981 and 1982, overall service availability declined due to funding limitations --vehicle-hours of service in September 1982 were about 5% lower than they had been in September 1981--and the Distributor came into service. The relative decline in off-peak travel appears to be attributable to the Distributor. However, an accurate assessment of this hypothesis requires more data.

Figures 3-3, 3-4, and 3-5 provide some of these data. The data which are the basis of these graphs are presented in Table B-2 of Appendix B. Figure 3-3 shows the distribution of all scheduled passenger-trips by the four principal periods of the day. Figure 3-4 depicts the contribution of Class 4 (periphery-periphery) trips to the general distribution shown in Figure 3-3. Figure 3-5 does the same for Class 2 and Class 3 (core-periphery) trips.

Figure 3-3 indicates that between 1981 and 1982 the number of scheduled passenger-trips declined across all periods of the day. Between 1982 and 1983 the number of scheduled trips increased across all time periods. However, within this general pattern of change there occurred differential changes by trip class.

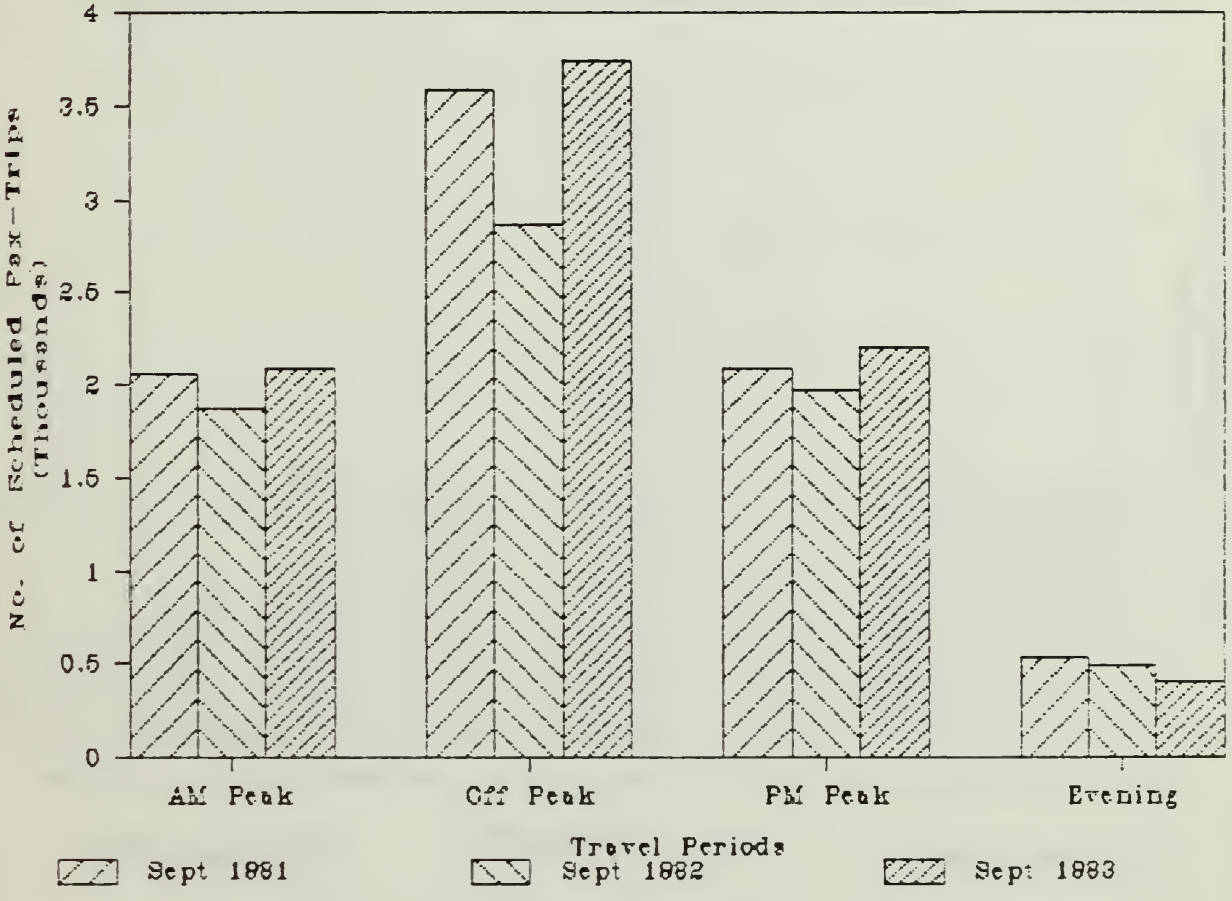
Figure 3-4 indicates that between 1981 and 1982, during the A.M. peak--the most changed of the two peak periods--Class 4 (periphery-periphery) trips declined 3%, from 1,060 to 1,030 trips per month. During the same interval, off-peak Class 4 trips declined 10%, from 2,460 to 2,220 trips. Thus, there was a 5% to 10% decline in all periphery-periphery trips between 1981 and 1982.

This rate of change can be compared to the rate for core-periphery trips in the same period (see Figure 3-5). During the A.M. peak, core-periphery trips declined 18%, from 840 to 690 trips per month. During the off-peak, core-periphery trips declined 45%, from 1,030 to 570 trips per month. Thus, there was a 20% to 45% decline in all core-periphery trips between 1981 and 1982.

It might be inferred from the difference between periphery-periphery and core-periphery trips in rate of decline that the Distributor--which directly affected the latter trips only--caused the disproportionate decline in core-periphery trips. This inference is supported by the fact that the decline in the off-peak period was more disproportionate than the decline in the A.M. peak period.

If indeed the Distributor was responsible for the differential rates of change by origin-destination characteristics, one could expect to see the persistence of these differential rates in the 1982-1983 period. This hypothesis will now be examined.

Figure 3-4 indicates that between 1982 and 1983, during the A.M. peak, Class 4 (periphery-periphery) trips increased 26%, from 1,030 to 1,300 trips per month. In this same time interval off-



Special-Needs Transportation Evaluation	TRIPS BY TRAVEL PERIOD (Adjusted and Factored from Weekly Data)	CTPS FIGURE 3-3
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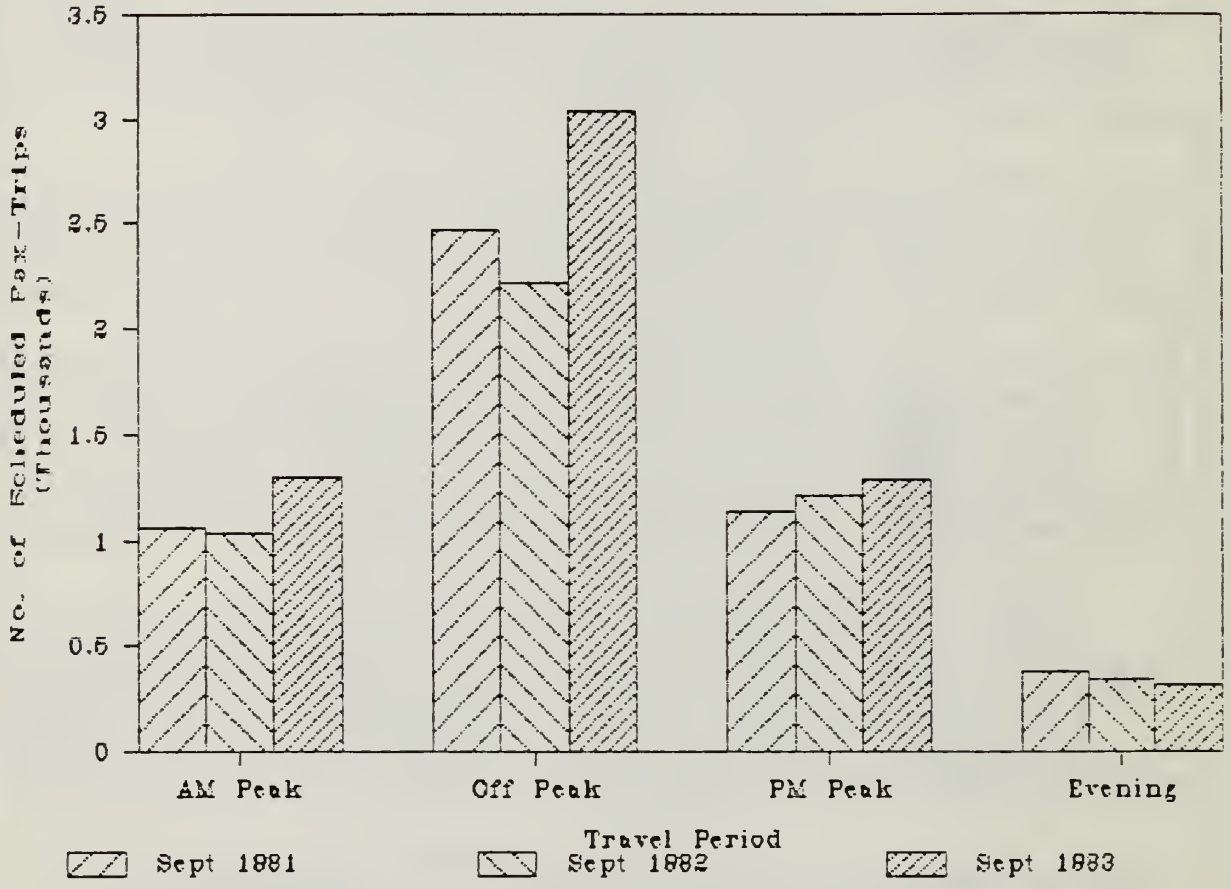
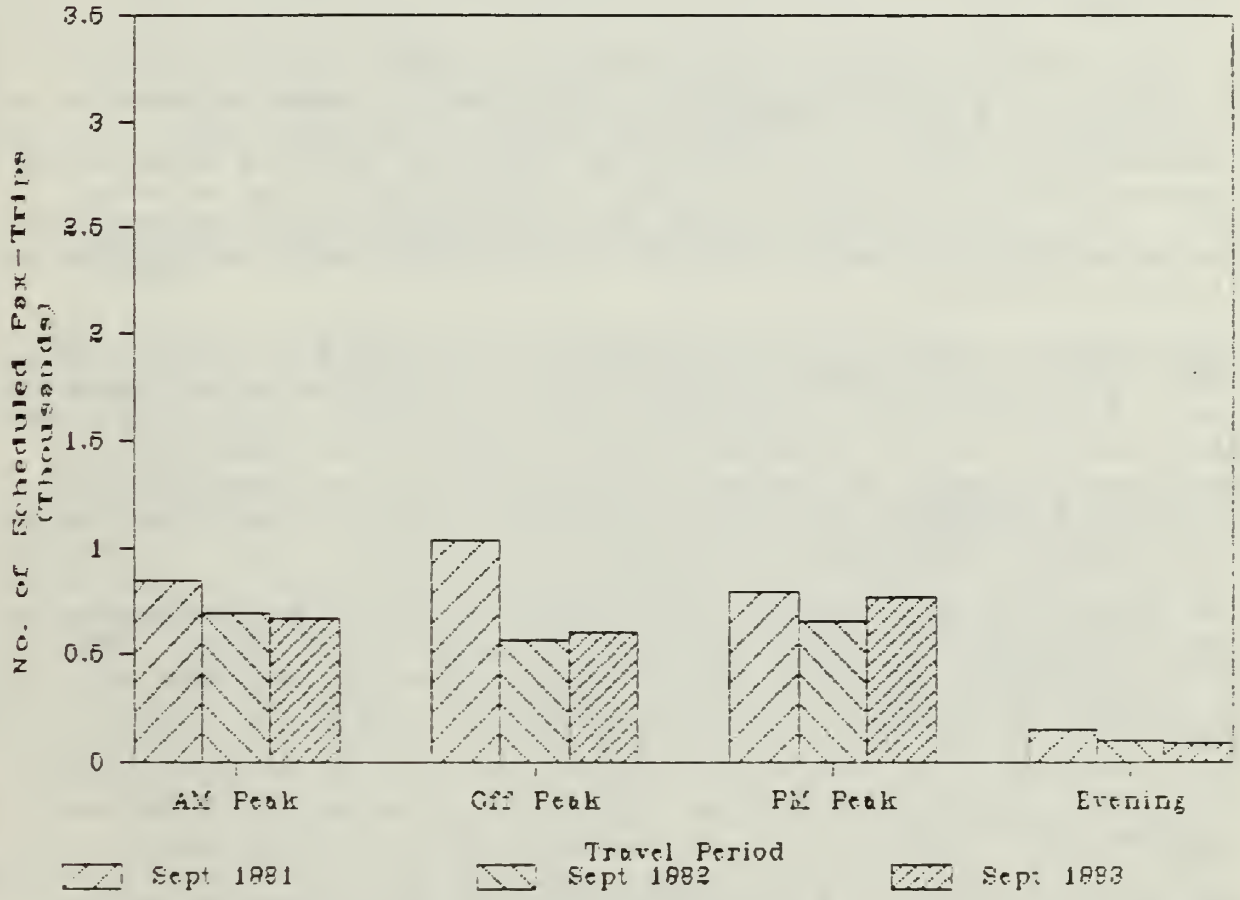


Special-Needs Transporation Evaluation	CLASS 4 TRIPS BY TRAVEL PERIOD (Adjusted and Factored fm Weekly Data)	CTPS
Technical Report 53a September 1985		FIGURE 3-4



Special-Needs Transportation Evaluation	CLASS 2&3 TRIPS BY TRAVEL PERIOD (Adjusted and Factored fm Weekly Data)	CTPS
Technical Report 53a September 1985		FIGURE 3-5

peak Class 4 trips increased 37%, from 2,220 to 3,030 trips per month. Thus, the periphery-periphery component of the 1982-1983 increase ranged between 25% and 35%.

Figure 3-5 shows that between 1982 and 1983, in the A.M. peak, core-periphery trips decreased 3% from 690 to 660 trips per month. During the off-peak, core-periphery trips increased 7%, from 570 to 610 trips per month. Thus, the core-periphery component of the 1982-1983 change ranged from a decrease of 5% to an increase of 5%.

In the 1982-1983 period, the rate of increase for periphery-periphery trips was much higher than that for core-periphery trips--those directly affected by the Distributor. Data discussed in section 3.1 indicated that the relative decline in core-periphery trips was not due to expansion of the service area. This conclusion and the data presented above suggest that the relative decline in core-periphery travel must be attributed to the Distributor.

The specific changes which occurred during the P.M. peak in the 1981-1982 and 1982-1983 periods do not exactly parallel those in the A.M. peak. Yet, in the P.M. peak there was also a clear re-distribution toward more periphery-periphery and fewer core-periphery trips. Furthermore, the P.M.-peak re-distribution, like the A.M.-peak, was proportionately less extreme than the re-distribution during the off peak.

The preceding data support the conclusion that implementation of the Distributor precipitated a re-distribution of trips. This re-distribution was characterized by a relative increase in periphery-periphery trips and a relative decrease in core-periphery trips. And this re-distribution effected a larger change among trips undertaken during the daytime off-peak period than those undertaken during either the A.M.- or the P.M.-peak periods.

The data in Figure 3-3 also indicate that the number of trips scheduled during the evening period declined steadily in the 1981-1983 period. Since the Distributor operated only during the day, this decline is not associated with the Distributor. There is no obvious explanation for this decline. During the sampling periods in 1981 and 1982, three vehicles were used for service between 6:00 P.M. and roughly 11:00 P.M. During the 1983 sampling period, three vehicles operated between 6:00 and 8:00 P.M., and two between 8:00 and roughly 11:00 P.M. This service change provided more evening service in 1983 than in either 1981 or 1982. Consequently, one might have reasonably expected to see an increase in the number of 1983 evening RIDE trips. Clearly, the evening service change does not account for the decline in evening ridership.

It has been suggested that a partial explanation for the 1981-1982 decline in evening trips may be found in the decrease in the number of special evening events served. Service to such events requires allocation of extra resources, which the MBTA could not afford to do as often in 1982 as in 1981. It has also been suggested that the continued decline in evening trips in 1983 may be explained by the decrease in vans available in the late evening. With only two, rather than three, vehicles available after 8:00 P.M., some potential users may have chosen not to travel during evening hours, since the likelihood of securing a late-evening return trip was lessened. Other possible explanations are shifts in travel behavior--a decline in demand for service or a difference in the pattern of passenger scheduling--that may have occurred independently of service changes. At present there is insufficient data to substantiate any of these hypotheses.

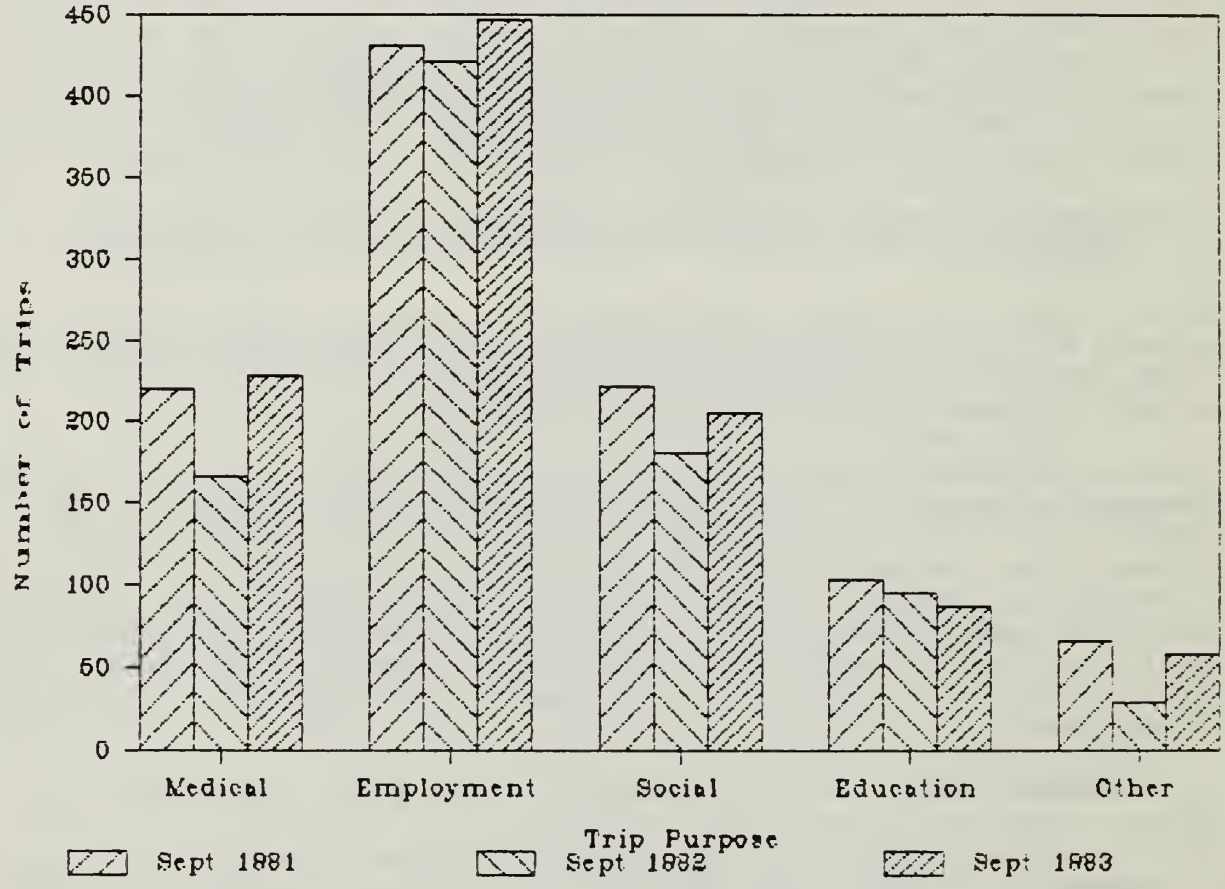
3.3 DISTRIBUTION OF SCHEDULED PASSENGER-TRIPS BY PURPOSE OF TRAVEL

Within each trip class, all passenger-trips were also sorted into one of five trip-purpose categories. For each year's sample, the distribution of trips by travel purpose was calculated as a simple percentage of total passenger-trips.

Figure 3-6 shows the distribution of scheduled passenger-trips by purpose of travel. The corresponding data is in Table B-3 of Appendix B. The distribution does not include the trips made to travel home. Home-bound RIDE and Distributor trips consistently represented one-half of all scheduled trips in the 1981, 1982, and 1983 sample data. This finding confirmed the hypothesis that nearly all trips were home-based trips. Consequently, the distribution in Figure 3-6 indicates users' purposes in traveling from home.

In the 1981, 1982, and 1983 samples, travel for employment purposes comprised between 40% and 45% of all scheduled trips. The start of Distributor service had little effect on the systemwide percentage of travel for employment purposes. However, as shown in Figure 3-7, the small 1981-1982 decline that did occur in employment-related trips included more core-periphery (Class 2 plus Class 3) than periphery-periphery (Class 4) trips. also, the overall 1982-1983 recovery in employment-related travel was due entirely to a large increase in these trips from one non-downtown area to another: core-periphery employment-related travel continued to decrease in this period. It can be inferred from these data that employment-related trips which were affected by the Distributor, i.e., core-periphery trips, declined disproportionately because of the Distributor's implementation.

The quantity of employment-related travel is notable because a survey of users[1] indicated that only 9% are employed full-time, and only another 6% are employed part-time. These percentages appear to indicate that a relatively small group of employed RIDE



Special-Needs Transportation Evaluation	TRIPS BY PURPOSE	CTPS FIGURE 3-6
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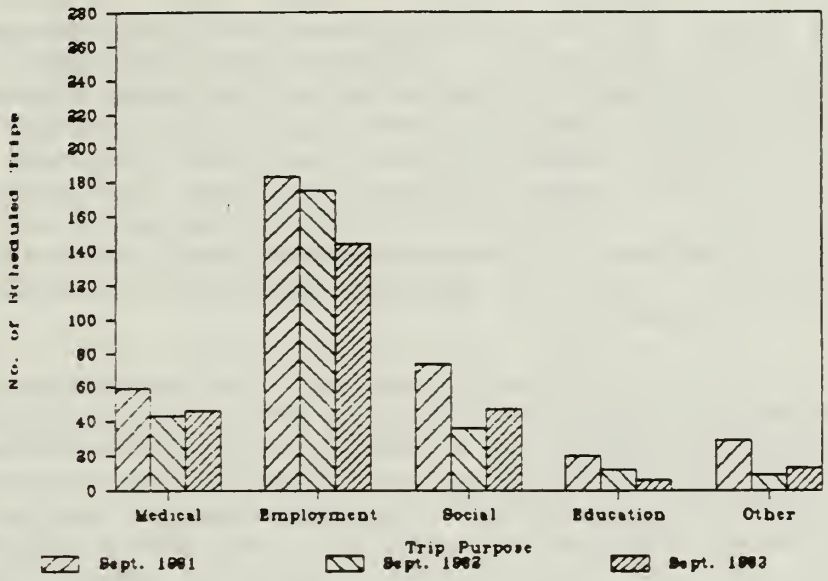
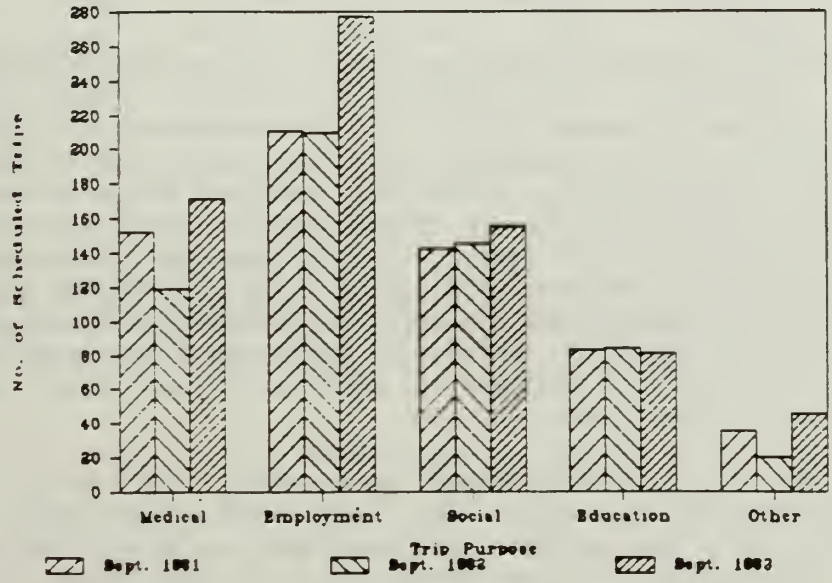
CLASS 2 & CLASS 3 TRIPS BY PURPOSE



CLASS 4 TRIPS BY PURPOSE



Special-Needs Transportation Evaluation	CLASS 2,3 AND 4 SCHEDULED PASSENGER TRIPS BY TRIP PURPOSE	CTPS
Technical Report 53a September 1985		FIGURE 3-7

and Distributor patrons use the system intensely. As a corollary, it can be inferred that most other patrons use THE RIDE and the Distributor much less frequently.[2]

Medical and social trips were the next two largest categories. In September 1981, September 1982 and September 1983, roughly 20% of all scheduled trips were undertaken for medical purposes. As shown in Figure 3-7, the 1981-1982 decline in travel for medical purposes was roughly equal for core-periphery (Class 2 plus Class 3) and periphery-periphery (Class 4) trips. However, the 1982-1983 increase in travel for medical purposes was due principally to an increase in periphery-periphery trips. The number of core-periphery trips for medical purposes remained basically unchanged in this period.

Some of the re-distribution of medical trips between 1981 and 1983 can be explained by service changes. The 1981-1982 decline in core-periphery (Class 2 & Class 3) and periphery-periphery (Class 4) medical trips can be explained by the general decline in service availability due to funding constraints in 1982. The relatively large increase in periphery-periphery medical trips between 1982 and 1983 can be explained by a general increase in service availability, which included service-area expansion. As the amount of area included in the "periphery" expanded throughout 1983, so too did the number of potential medical opportunities in the periphery. As a consequence, one would expect more periphery-periphery (Class 4) medical trips in 1983 than in 1982.

However, a plausible explanation for the low number of 1983 core-periphery (Class 2 & Class 3) medical trips is not so obvious. Overall funding and service availability increased between 1982 and 1983. One might have reasonably expected these medical trips to increase more than they did. The Massachusetts General Hospital (MGH) and the Massachusetts Rehabilitation Hospital (MRH) are the major medical centers located within the "core" area. Even with the start of Distributor service, most MGH-bound trips were maintained as direct trips, because MGH was one of the two transfer points between THE RIDE and the Distributor. Also, a serious attempt was made to make all MRH-bound trips direct. Some MRH-bound trips did, however, require a vehicle transfer, and the relatively low number of 1983 core-periphery medical trips may be due to these trips.

Travel for social purposes made up roughly 20% of all scheduled trips in September of 1981, 1982, and 1983. However, as shown in Figure 3-7, there was a precipitous fall in core-periphery (Class 2 plus Class 3) social trips between 1981 and 1982. Social trips between peripheral areas actually increased between 1981 and 1982. In the 1982-1983 period, social trips increased for all trip classes. It should be noted that, even with this recovery, the number of 1983 social trips between core and periphery did not attain the 1981 level. The Distributor appears to have been responsible for supressing the number of core-periphery social trips.

Education-related travel made up about 10% of all trips in all three samples. In Figure 3-7, it is clear that between 1981 and 1982, education-related travel declined significantly for core-periphery (Class 2 plus Class 3) trips, while it remained basically unchanged for periphery-periphery trips. This pattern was repeated in the 1982-1983 interval. It can be inferred from these data that the Distributor--which affected core-periphery trips directly--was at least partially responsible for the decline in education-related trips between the core and peripheral areas in the 1981-1983 interval.

Travel for all other purposes represented approximately 5% of all scheduled trips in all three samples.

The foregoing data support the thesis that the percentage of trips by trip purpose was basically the same in 1981, 1982, and 1983, that the introduction of the Distributor significantly changed the balance of trips toward more periphery-periphery trips and fewer core-periphery trips for all trip purposes. Graphs and tables concerning specific changes by trip class are presented in Appendix E.

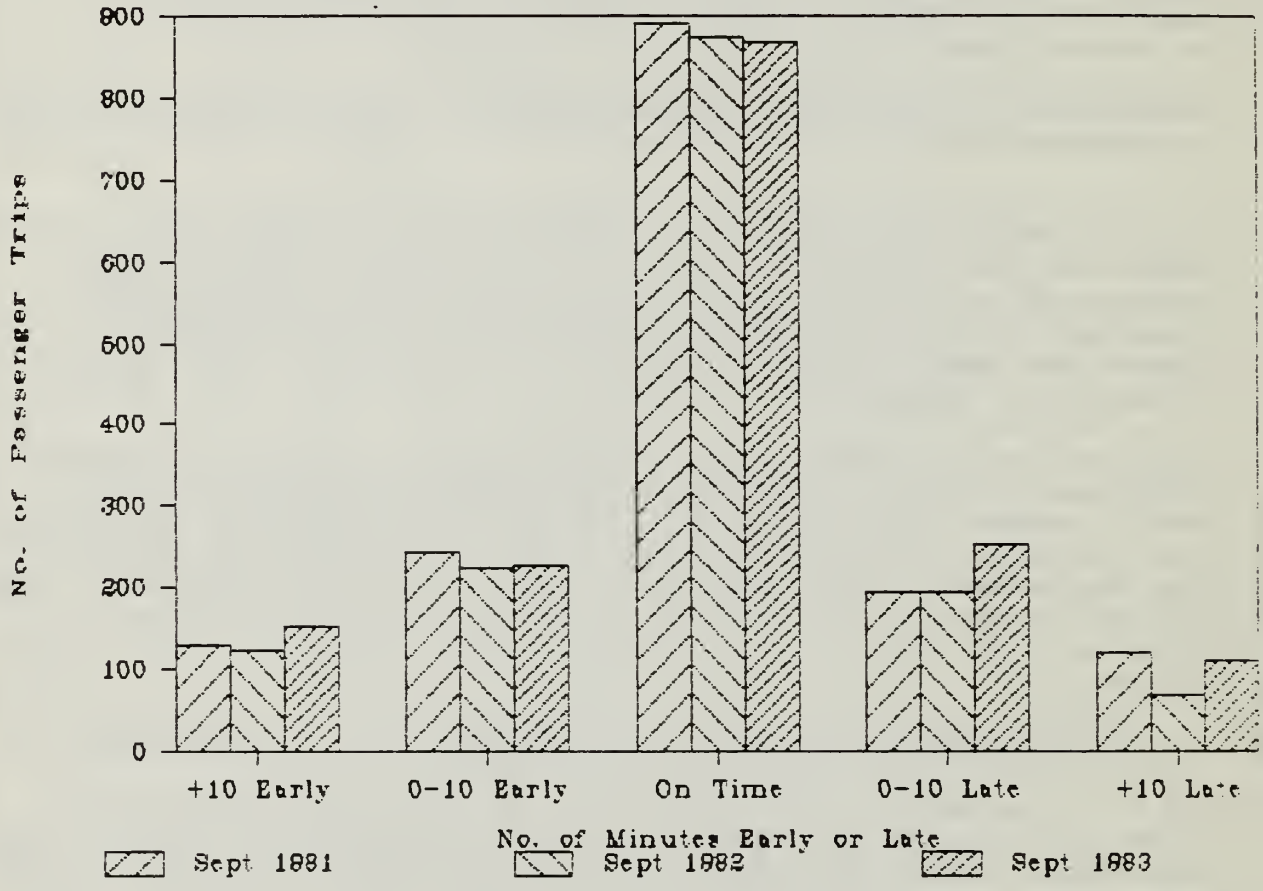
It should be noted that the disproportionate decline in Class 2 and Class 3 trips documented in this section and section 3.2 should not be construed as a decline in discretionary travel between the core and periphery. The data presented here document that there was a significant decline in core-periphery travel for all trip purposes--significantly, even work-related travel was affected--and not merely for travel which could be termed discretionary.

3.4 DISTRIBUTION OF SCHEDULED PASSENGER-TRIPS BY WAIT TIME

The distribution of passenger wait time was calculated in two steps. First, for each passenger-trip the difference between actual and scheduled pick-up time was calculated. Second, these time differences were sorted into one of nine categories. The nine categories were exactly-on-time pick-ups, four time intervals of early pick-ups, and four intervals of late pick-ups. A plot of the distribution of passenger wait times from the 1981, 1982, and 1983 sample data is shown in Figure 3-8. The data from which this plot was derived are presented in Table 3-3.

Between 55% and 60% of all passenger-trips in the sample were begun exactly on time. However, the MBTA's policy is to consider a passenger-trip to be "on time" if the passenger is picked up within 10 minutes, plus or minus, of his or her scheduled pick-up time. By this criterion, roughly 85% of all passenger-trips in the 1981, 1982, and 1983 samples were made on time, 8% were early, and 7% were late.

The data on passenger wait time were also analyzed by trip class (i.e., by the origin-destination characteristics of the trips).



Special-Needs Transportation Evaluation Technical Report 53a September 1985	DISTRIBUTION OF TRIPS BY WAIT TIME (From Weekday Sample Data)	CTPS FIGURE 3-8

No. of Minutes Early or Late	1981	(%)	1982	(%)	1983	(%
20 Min. Early	50	3.2	30	1.9	41	2.6
15-20 Min. Early	24	1.5	23	1.5	35	2.2
10-15 Min. Early	55	3.5	69	4.4	75	4.8
0-10 Min. Early	242	15.4	224	14.2	226	14.4
Exactly On Time	899	56.5	873	55.5	867	55.1
0-10 Min. Late	193	12.3	194	12.3	252	16.0
10-15 Min. Late	49	3.1	24	1.5	59	3.7
15-20 Min. Late	30	1.9	11	0.7	18	1.1
20 Min. Late	41	2.6	34	2.2	79	5.0
Total Trips	1573		1482		1605	

Special-Needs Transportation Evaluation	DISTRIBUTION OF TRIPS BY WAIT TIME, WEEKDAYS ONLY	CTPS
Technical Report 53a September 1985		TABLE 3-3

This analysis documented some difference in wait time by trip class, but the differences were not extreme. There were slightly longer average wait times on RIDE trips than on Distributor trips.

Apparent disagreement between patrons and the MBTA regarding on-time service performance has probably been a result of patrons' defining on-time literally while the MBTA defines on-time as within 10 minutes of the scheduled pick-up time. However, some users have suggested informally that THE RIDE's and the Distributor's on-time performance is much worse than the actual sample data indicate. One reason for this perception may be the absolute number of trips served early and late. In September 1983, 9,064 passenger-trips were scheduled on THE RIDE and the Distributor. Roughly 78% of these trips were completed, and approximately 15% of the completed trips were delivered early or late. This means that about 1,060 trips were not served on time. If for example, 10% of the affected passengers voiced a complaint in the same forum, the most organized and attentive of RIDE/Distributor users--who would attend such a forum--would be influenced in their perception of on-time performance.

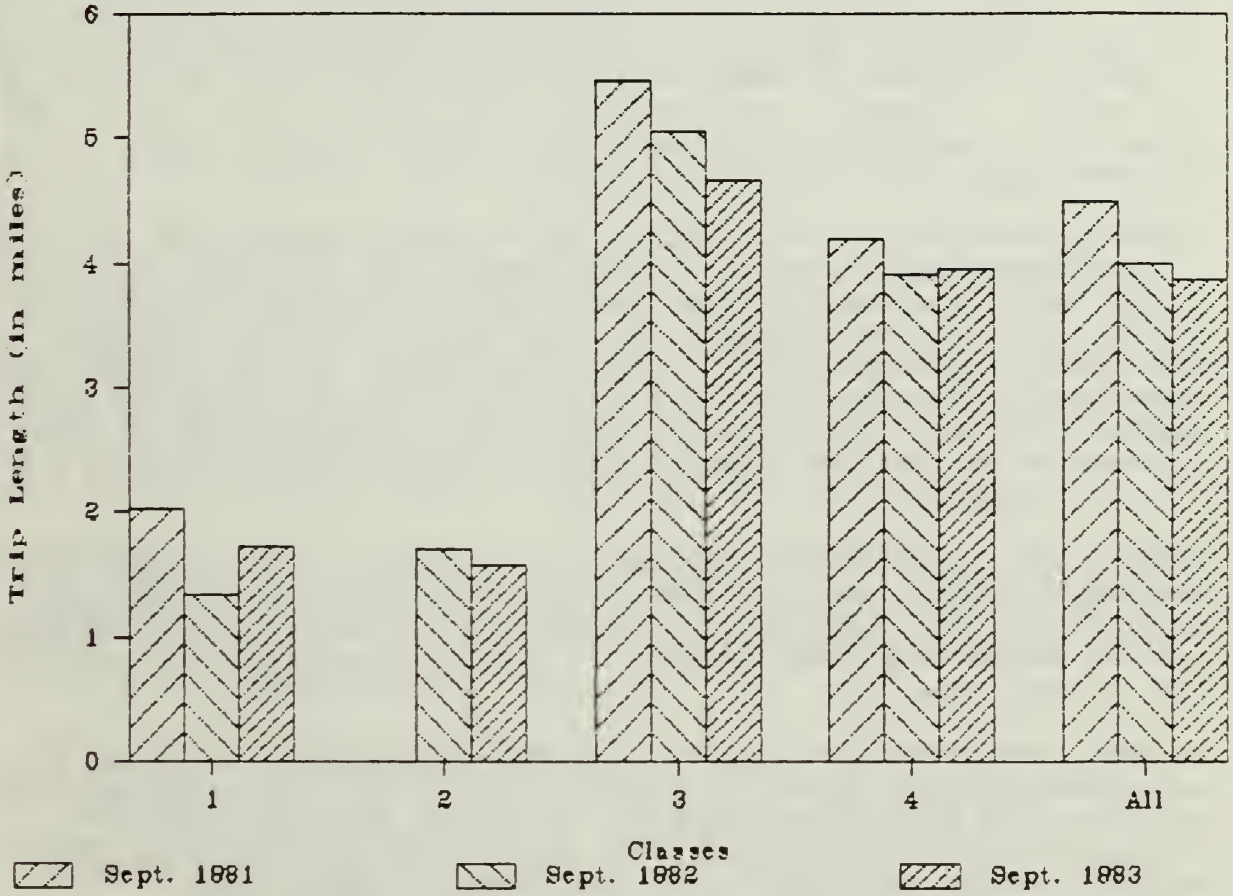
3.5 TRIP DISTANCE

Trip distance was calculated for September 1981, September 1982, and September 1983 as a simple average for each trip class and for all trips. The results are shown in Figure 3-9, (the data used to develop this figure are presented in Table B-4 of Appendix B). The 1981-82 Class 1 decline and the results for Classes 2 and 3 in 1982 and 1983 require special interpretation, as will be explained.

As shown in Figure 3-9, average trip distance declined for most trips during the 1981-1983 period. Between 1981 and 1982, the systemwide average trip distance declined by 11%, from 4.5 to 4.0 miles. In the 1982-1983 period, it declined another 3%, to 3.9 miles.

Class 1 (core-core) trips deviated from this general trend. Figure 3-9 indicates that, between 1981 and 1982, the length of an average Class 1 trip declined 34%, from 2.0 to 1.3 miles; however, this is probably attributable in large part to differences in the nature of the data collected before and after the start of the Distributor. The Distributor could only serve the portion of each trip that lay on its fixed route, and only that portion of each core-core trip was recorded in the statistics. The true origin and destination were not recorded. Therefore, 1982 core-core trips whose origin or destination did not lie on the fixed route would appear to be shorter than the same trips made in 1981, but in reality were not.

The statistics indicate a 1982-83 increase in Class 1 trip distance of 29%, from 1.3 to 1.7 miles. What is responsible for



Special-Needs Transportation Evaluation Technical Report 53a September 1985	AVERAGE TRIP DISTANCE (From Completed Trip Data)	CTPS FIGURE 3-9

the increase is not known. Because Class 1 trips were a small percentage of all completed trips, this increase did not alter the overall trend.

The data in Figure 3-9 on Class 2 (linked core-periphery) and Class 3 (direct core-periphery) trip distances requires special interpretation. Class 2 trip distance assesses only the portion of a 1982 or 1983 core-periphery trip that was ececuted on the Distributor, i.e., only the downtown portion--not the actual origin-to-destination trip distance. (In 1981, there were no Class 2 trips.) Class 3 (direct core-periphery) trip distance in Figure 3-9 has one meaning in 1981, and another in 1982 and 1983. In 1981, a Class 3 trip was indeed executed directly from point of origin to point of destination (the average trip distance was 5.5 miles). However, the 1982 and 1983 Class 3 trip distances in Figure 3-9 assess only the portion of each core-periphery trip that was executed on THE RIDE.

In 1982 and 1983, all core-periphery trips consisted of one trip on the Distributor and one on THE RIDE. For purposes of calculating trip distance, it was not feasible to match, for each actual trip, the separately recorded data on the Distributor and the RIDE components of the trip. Therefore, it was assumed that (defining Class 2 and Class 3 trip distances as explained above), average 1982 and 1983 core-periphery trip distances were equal to the sum of an average Class 2 trip distance and an average Class 3 trip distance.

Using this basis of calculation, the average "true" origin-to-destination distance of core-periphery trips in 1982 was 6.8 miles. Of this distance, 1.7 miles was the Distributor distance, and 5.1 miles the RIDE distance. This core-periphery distance is 24% greater than that of a comparable trip in 1981.

In 1983, the average "true" origin-to-destination distance of core-periphery trips was 6.2 miles. Of this, 1.6 miles was executed on the Distributor and 4.7 miles on THE RIDE. This distance is 13% longer than that of a comparable trip in 1981, and 9% shorter than that of a comparable trip in 1982.

Average trip distance for periphery-periphery (Class 4) trips declined between 1981 and 1982 by 7 percent, from 4.2 to 3.9 miles. In 1983 it increased by 1% to 4.0 miles.

3.6 TRIP TIME

Trip time was calculated for September 1981, September 1982, and September 1983 as a simple average for total trips and for Class 1 (core-core), Class 3 (direct core-periphery), and Class 4 (periphery-periphery) trips. The calculation of Class 2 (linked core-periphery) average trip times was slightly more complex. A simple average trip time was first calculated for the core portion of the linked trip alone. To this average were added an

average Class 3 (direct core-periphery) trip time and an average out-of-vehicle wait time of 15 minutes.[3]

Average trip time by trip class is plotted in Figure 3-10. The data used to generate this graph are presented in Table B-5 of Appendix B.

Three immediate inferences can be drawn from the data in Figure 3-10. The first is that in the 1981-1983 period, there was a significant increase in average Class 1 (core-core) trip time. The second is that average Class 2 (linked core-periphery) trip times were much longer than average Class 3 (direct core-periphery) trip times. The third is that there was little apparent change in average Class 4 (periphery-periphery) trip time.

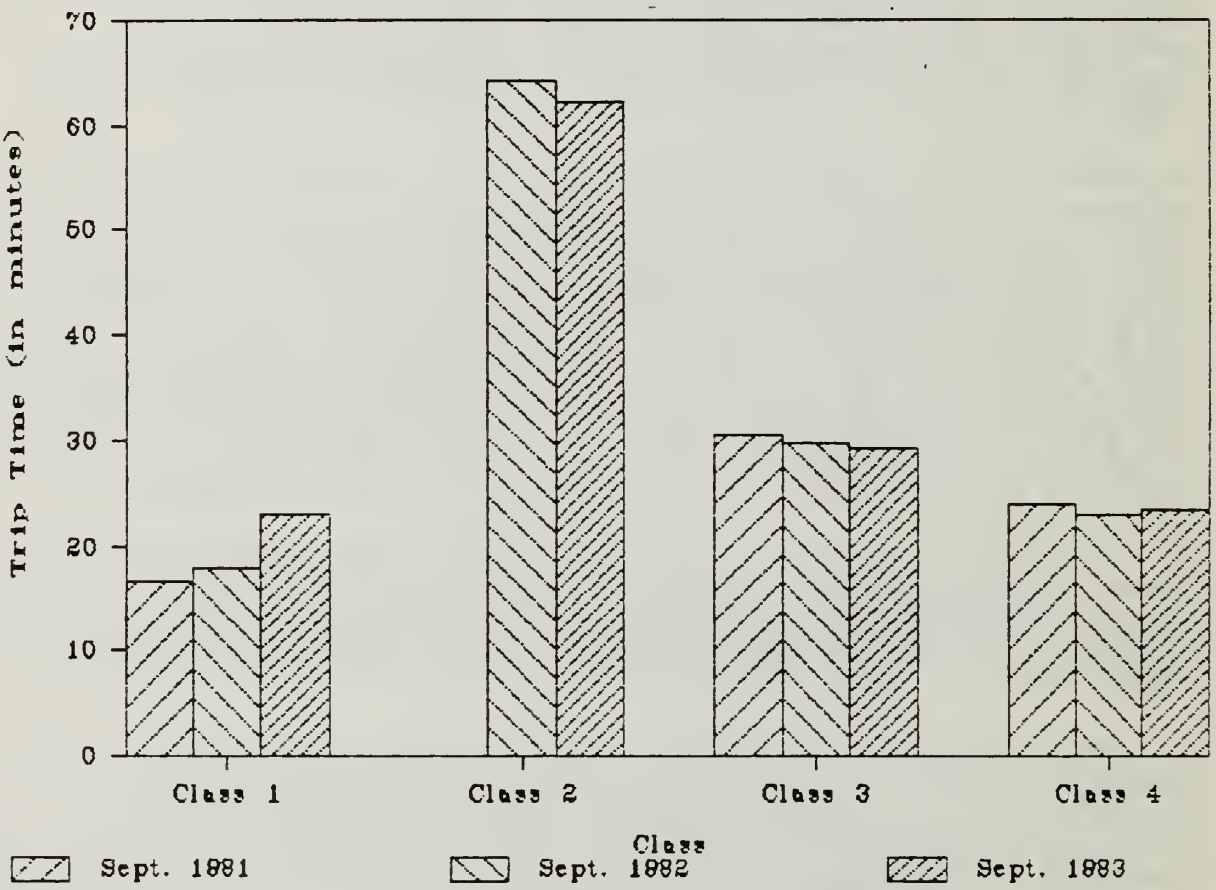
Between 1981 and 1983, average Class 1 (core-core) trip time increased by 37%, from 16.7 to 22.9 minutes. It should be noted that the 1981 Class 1 trip time was the passengers' door-to-door time. The 1982 and 1983 Class 1 trip time was the passengers' spent riding along a fixed route, from boarding to alighting. This measure does not include the passengers' travel time from their origins to the fixed route at the start of their trips, nor their time from the fixed route to their final destinations at the end of their trips. Thus, for some Class 1 trips, true trip times in 1982 and 1983 were likely longer than indicated here; there is no empirical data to indicate how much longer.

As explained in section 3.5, the average trip lengths of "true" linked core-periphery trips in 1982 and 1983 are directly comparable to 1981 Class 3 (direct core-periphery) average trip lengths. By logical extension, the corresponding average trip times are also comparable.

In 1981, prior to the Distributor, average core-periphery (i.e., Class 3) trip time was roughly 30 minutes. An average core-periphery trip in 1982--assuming the trip necessitated a transfer--required 64 minutes.[4] This 64-minute travel time included 19.5 minutes of travel on the Distributor, 29.8 minutes of travel on THE RIDE, and 15 minutes of wait time between these two travel modes. In the 1981-1982 interval average trip time for core-to-periphery trips increased by 110%.[5]

Between 1982 and 1983, the average trip time for linked core-periphery travel decreased by approximately 2 minutes, to 62.3 minutes.[6] This is still 104% higher than the average core-periphery trip time in 1981, when the service was direct.

Between 1981 and 1983, average Class 4 (periphery-periphery) trip time went down, then up--but not far in either direction. There was a 2% difference between the 1981 and 1983 average periphery-periphery trip times.



Special-Needs Transportation Evaluation Technical Report 53a September 1985	AVERAGE TRIP TIME (No Class 1 Waiting Time in '82 or '83)	CTPS FIGURE 3-10

NOTES TO CHAPTER 3

[1]See the CTPS technical report, Special-Needs Transportation Evaluation: Analysis of the Special-Needs Users Transportation Survey (to be published following the present report).

[2]Conclusive evidence on this hypothesis would require determining the number of riders (as opposed to passenger-trips) represented in the sample and the frequency with which they used the services. These analyses were not performed on the available data because, more often than not, user-identification numbers--the necessary means for identifying individual users of the system--were missing from the passenger-log data. The data collected for September 1984 do include the ID number. Once they are analyzed, more conclusive statements can be made about matters that hinge upon the number of individual users in the system and the frequency of their travel.

[3]The addition of wait time was made necessary because Class 1 and Class 2 trips were served by the Distributor in 1982 and 1983. In 1981 Class 1 trips were provided door-to-door at a fixed time, and there were no Class 2 trips. Starting in 1982 travelers making these trips were required to wait along a fixed route for the Distributor.

Users were asked to estimate their average wait time for the Distributor in a survey of all RIDE and Distributor users. The survey specifically asked for an estimate of wait time for the Distributor only. The weighted mean wait time was calculated to be 15 minutes.

In the analysis of trip time, this average wait time was added only to Class 2 trips because of how the Distributor actually operated. While the Distributor was intended to be operated on a fixed time schedule, the user survey indicates that it actually operated as a reservation service. Persons making Class 1 trips were likely to have made a reservation for a pick-up at a given time. Therefore, they were not likely to have had to wait 15 minutes. While persons making Class 2 trips also made reservations for Distributor travel, these travelers had to transfer to or from the RIDE, and the two portions of these linked trips often could not be coordinated to eliminate wait time.

To the degree that the Distributor could not hold to its scheduled reservations--and the user survey indicates that this was often the case--the addition of wait time to actual in-vehicle travel time is appropriate to Class 1 as well as and Class 2 trips. Class 1 average trip time calculated with waiting time is presented in Figure F-1 and Table F-1 of Appendix F.

[4]It would be difficult to determine exactly how many 1982 linked core-periphery passenger trips required 64 minutes, because there is no readily available way of linking the RIDE and the Distributor portions of linked trips. However, 64 minutes is a true average trip-time value.

The statistics which are available--which include standard-deviation statistics--make it possible to estimate that roughly 15% of all linked trips were executed in 37 minutes or less; on the other hand, approximately 15% of all linked trips required 92 minutes or more to execute.

[5]Average trip speed data emerges naturally from the data on trip distance and trip time. Because trip speed data only reinforce the conclusions presented here, they are not discussed in the text. They have, however, been included in Appendix G.

[6]The exact number of 1983 linked core-periphery passenger-trips which required 62 minutes to complete cannot be readily estimated, for reasons explained above, in note 4. The statistics which are available make it possible to estimate that roughly 15% of linked passenger-trips were completed in 31 minutes or less, and another 15% required 94 minutes or more to execute.

4 VEHICLE PRODUCTIVITY

4.1 METHOD OF ANALYSIS

One of the primary reasons for creating the Downtown Distributor was the belief that it would improve system efficiency. To assess whether or not this goal was achieved, this study applied several measures of system efficiency. The number of passenger-trips per hour of vehicle service proved to be the most conclusive of these measures. Therefore, it was used as the basis for assessing improvement in system efficiency.[1]

The number of passenger-trips per vehicle-hour was calculated in the following way. For each passenger log, the difference between the actual pick-up time for the first scheduled trip and the actual drop-off time for the last scheduled trip was calculated. The difference between these two times was considered to be the vehicle's in-service time for that day. One hour was added to the result for each log, to account for the dead-head time--the time a vehicle travels with no scheduled passengers at the start and end of its daily tour. This sum represented the total daily service time for each vehicle-day. Passenger-trips per vehicle-hour were calculated for each vehicle-day by dividing the number of scheduled trips served (from the log) by the total daily service time.[2]

Because the Distributor was operated by two dedicated vehicles, it was possible to isolate its contribution to vehicle productivity. The basic approach of the analysis was to compare passenger-trips per vehicle hour for Distributor vehicles with that for non-Distributor vehicles used in that service.

An important consequence of starting Distributor service was the creation of linked trips--trips with two, separate trip components, one undertaken on the Distributor, the other on the RIDE. These components were recorded in separate logs, and the resultant "double counting" of single linked trips had to be eliminated before vehicle-productivity rates could be calculated for 1982 and 1983 that would be directly comparable to 1981 rates. This was facilitated by linked trips having been were identified by the scheduler on the Distributor's passenger logs. Each portion of each linked trip was assigned a value of one-half, and the number of scheduled trips carried by the Distributor and the RIDE was adjusted down appropriately.

4.2 COMPARISON BY YEAR AND VEHICLE TYPE

Figure 4-1 presents passenger-trips per vehicle-hour by year and vehicle type. It should be noted that the Distributor versus non-Distributor distinction did not exist in 1981. The 1981 rate of 1.99 passenger-trips per vehicle-hour is the rate for all vehicles in that year; it is represented in the Distributor-vehicle and non-Distributor-vehicle portions of the graph and table for purposes of comparison only.

1981 vs. 1982

Comparing 1981 and 1982 Distributor-vehicle, vehicle productivity --which applies to Class 1 (core-core) and Class 2 (linked core-periphery)* trips--in Figure 4-1 affords only an approximate picture of the change that took place. This is because the 1981 figure, as has been explained, actually represents systemwide vehicle productivity, while the 1982 figure accurately reflects the rate for Distributor vehicles alone. Because there is no better data available for comparison, these data must suffice. They indicate that between 1981 and 1982, vehicle productivity for core-core and linked core-periphery travel fell from 1.99 to 1.88 passenger-trips per vehicle-hour.

Comparing the 1981 and 1982 data for non-Distributor vehicles--which data cover Class 3 (direct core-periphery) and Class 4 (periphery-periphery) trips--affords a good estimate of actual change. Non-Distributor vehicles are RIDE vehicles, and in both years these vehicles provided direct service from point of origin to point of destination. These data suggest that between 1981 and 1982, vehicle productivity for Class 3 and Class 4 trips rose from 1.99 to 2.01 passenger-trips per vehicle-hour.

In the 1981-1982 interval, systemwide vehicle productivity for all vehicle rose from 1.99 to 2.01 passenger-trips per vehicle-hour.

Clearly, the 1982 vehicle-productivity rate for Distributor vehicles, i.e., for core-core and linked core-periphery* trips, was below the system average. Since in 1982, Distributor vehicles were less efficient that non-Distributor vehicles, theoretically the Distributor should have reduced the 1982 average vehicle-productivity rate (from non-Distributor rate). In fact, it had little apparent effect on that rate.

1982 vs. 1983

Between 1982 and 1983, vehicle productivity on Distributor vehicles (for core-core and linked core-periphery* trips) rose from 1.88 to 1.99 passenger-trips per vehicle-hour. Non-

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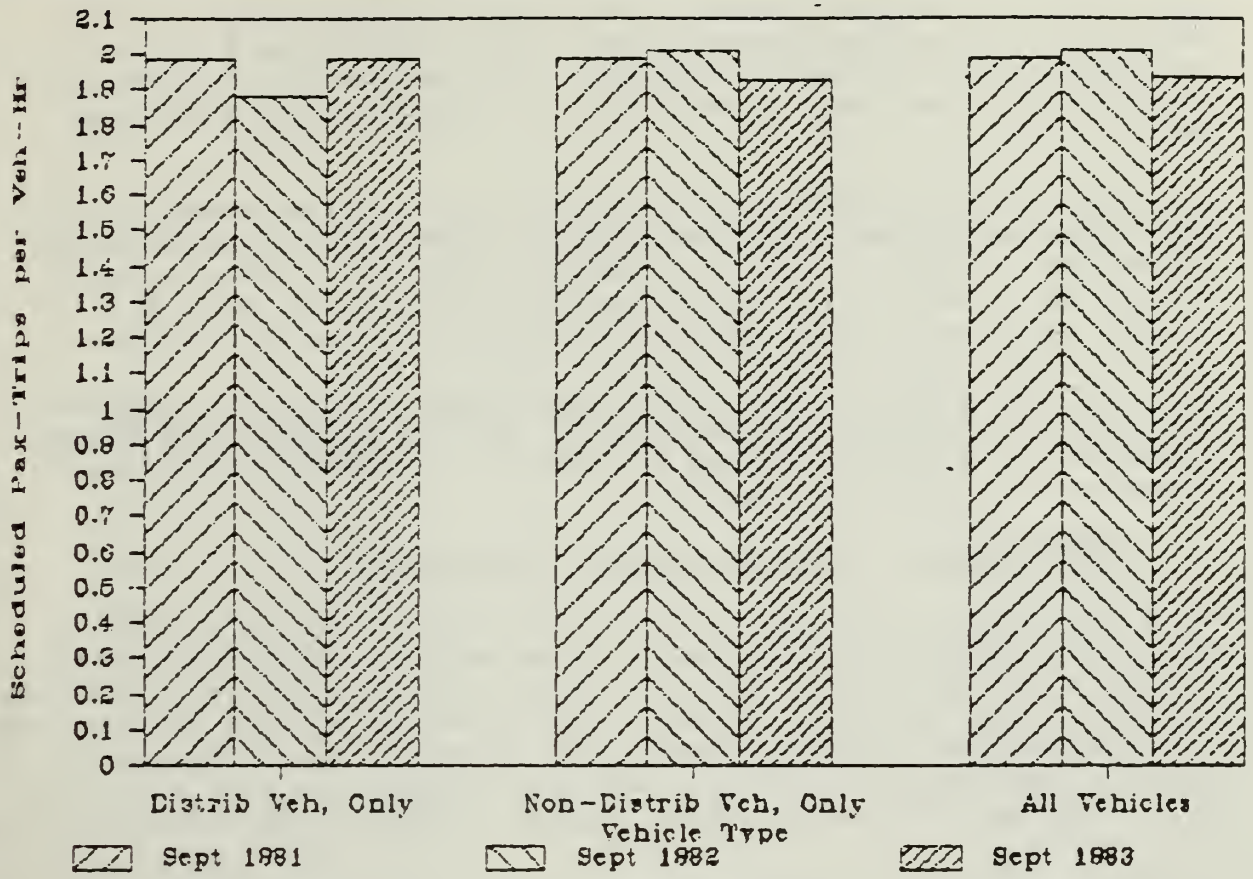
*The core portion of linked core-periphery trips.



	1981	1982	1983
Distrib Veh, Only	1.99	1.88	1.99
Non-Distrib Veh, Only	1.99	2.01	1.93
All Vehicles	1.99	2.01	1.93

Special Needs Transportation Evaluation	Vehicle Productivity (All Scheduled Trips, Including Deadhead, Weekdays Only)	CTPS
Technical Report 53a September 1985		FIGURE 4-1

Distributor vehicles' vehicle productivity (for direct core-periphery and periphery-periphery trips) fell from 2.01 to 1.93 passenger-trips per vehicle-hour. In this period, systemwide productivity also fell from 2.01 to 1.93 passenger-trips per vehicle-hour.

The 1983 vehicle-productivity rate on Distributor vehicles (for core-core and linked core-periphery* trips) was somewhat above the system average. While in theory this should have brought systemwide productivity above the non-Distributor rate for 1983, in fact the improvement was not detected in the statistics.

The findings indicate that the Distributor made only a marginal difference in vehicle productivity. To the degree that vehicle productivity reflects system efficiency, efficiency was basically unaffected by the Distributor.

4.3 COMPARISON BY TIME OF DAY AND VEHICLE TYPE

The vehicle-productivity figures discussed so far are average, day-long productivity figures. These data could not indicate whether the Distributor may have been more productive at certain periods of the day than others. To investigate this possibility, a second set of vehicle-productivity figures was calculated. This set was used to evaluate vehicle productivity in the A.M.-peak, daytime off-peak, and P.M.-peak periods (defined in section 3.2).

Vehicle productivity by time of day for Distributor vehicles (for core-core and linked core-periphery* trips) is shown in Figure 4-2. Vehicle productivity by time of day for non-Distributor vehicles (for direct core-periphery and periphery-periphery trips) is shown in Figure 4-3. The data from which these graphs were generated can be found in Table 4-1 and Table 4-2, respectively. Note that the data in Figures 4-2 and 4-3 are not directly comparable with the data in Figure 4-1, because, for the former, deadheading was included in vehicle-hours, and for the latter it was not.

Figure 4-2 clearly shows that the Distributor functioned much more efficiently in the peak periods than during the daytime off-peak. In 1982, the Distributor's vehicle productivity during the A.M.-peak period was 2.92 passenger-trips per vehicle-hour; vehicle productivity during the daytime off-peak period was 0.77 passenger-trips per vehicle-hour. P.M.-peak vehicle productivity was 2.48 passenger-trips per vehicle-hour. In 1983, A.M.-peak period vehicle productivity on the Distributor was 2.84 passenger-trips per vehicle-hour, while daytime off-peak vehicle productivity was 1.05 passenger-trips per vehicle-hour. P.M.-peak vehicle productivity was 2.44 passenger-trips per vehicle-hour.

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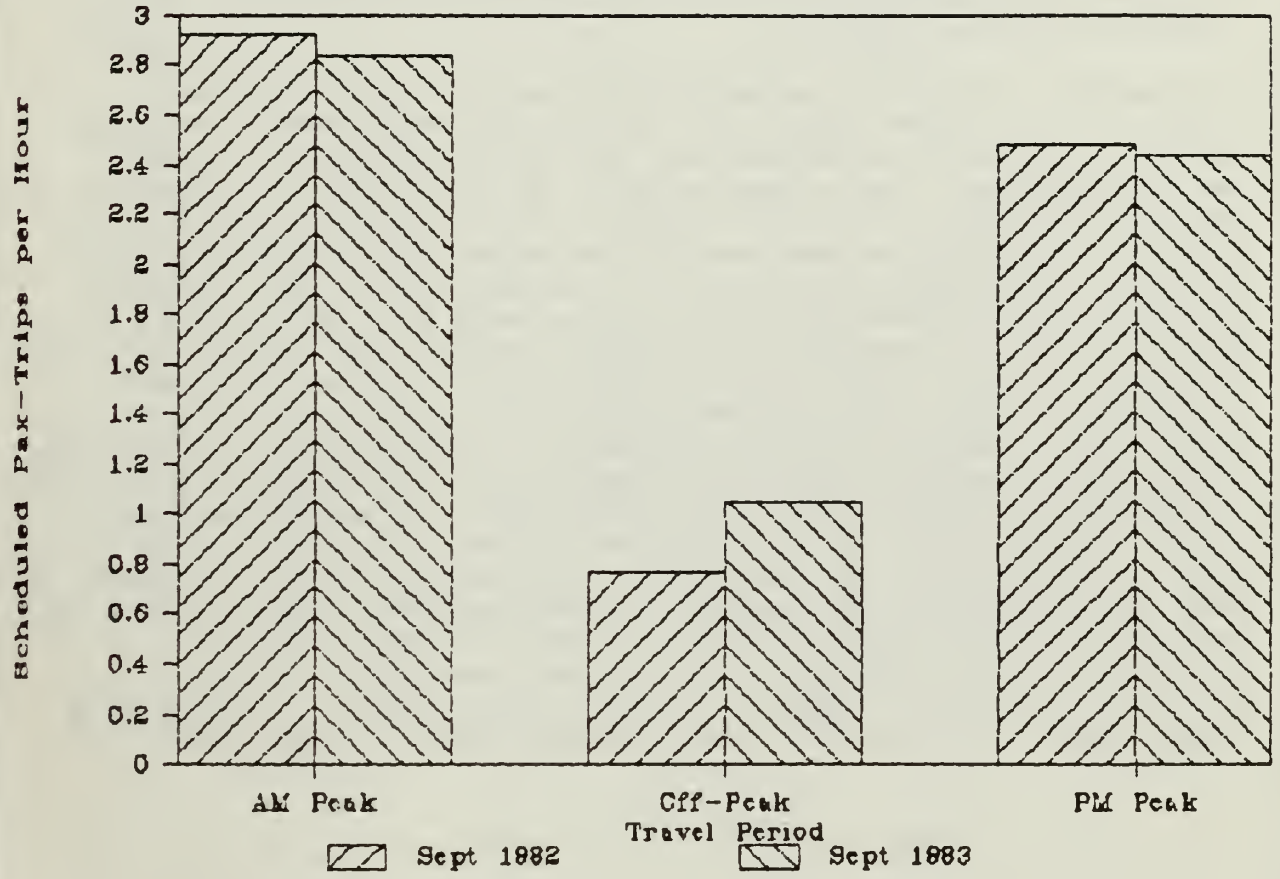
*The core portion of linked core-periphery trips.



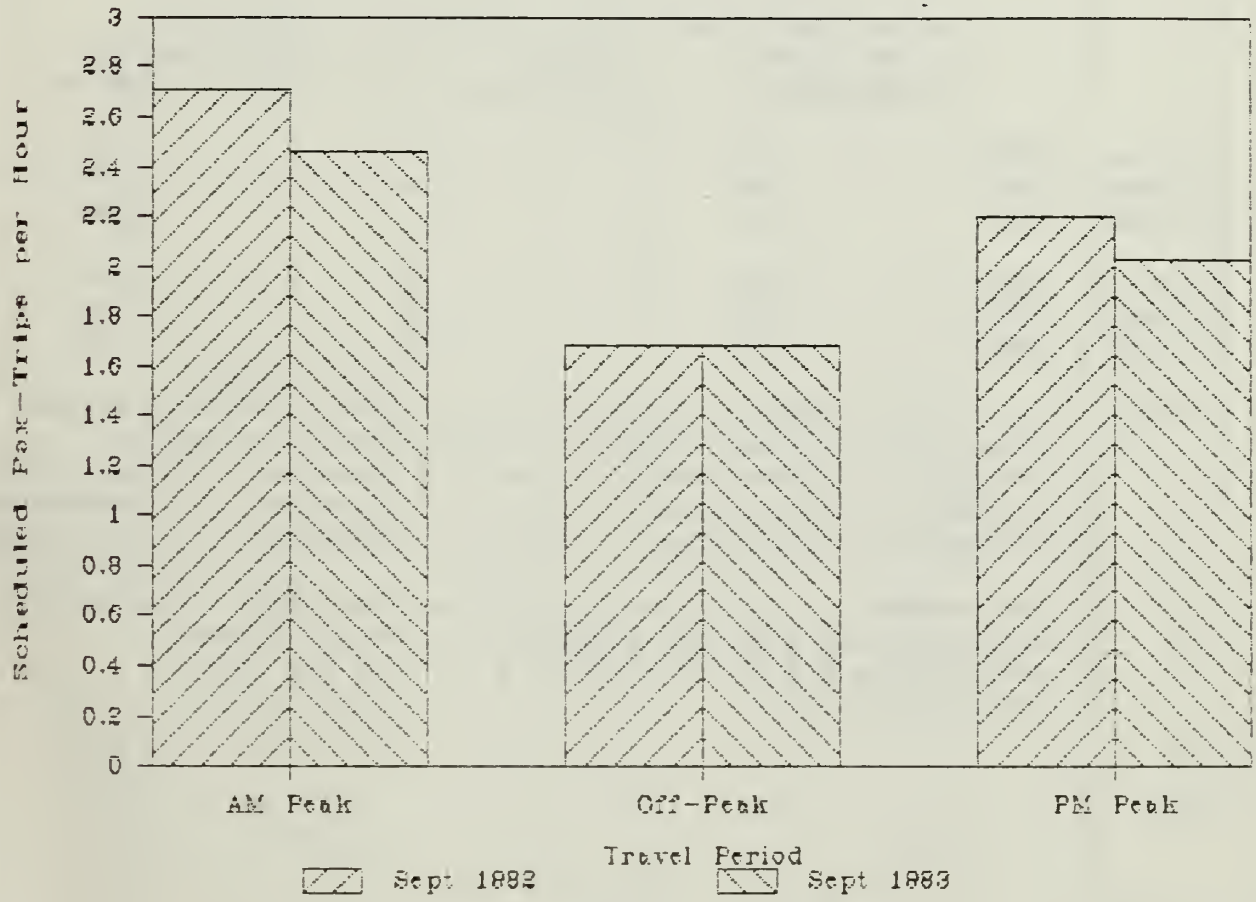
Vehicle-hours do not include deadheading time.

Special-Needs Transportation Evaluation	VEHICLE PRODUCTIVITY --DISTRIBUTOR VEHICLES	CTPS FIGURE 4-2
Technical Report 53a September 1985		

Figure 4-3 shows that vehicle productivity for non-Distributor vehicles (for direct core-periphery and periphery-periphery trips) also varied by time of day, but that the difference between the peak periods and the daytime off-peak is not so extreme as that for Distributor vehicles. While Distributor vehicles are slightly more efficient than non-Distributor vehicles during the peak periods, they are significantly less efficient during the daytime off-peak period.

The data suggest that during the morning and afternoon peak periods, the Distributor improved system efficiency.[3] By contrast, the Distributor diminished system efficiency during the daytime off-peak period.

The marked difference between peak and off-peak vehicle-productivity rates argues for evaluating Distributor service during particular times of the day--particularly the peak periods--rather than necessarily on an all-or-nothing basis. The data in Tables 4-1 and 4-2 indicate that in 1982 and 1983 the Distributor provided peak-period service more efficiently (in terms of passenger-trips per vehicle-hour) than did THE RIDE. The 1983 data presents the more favorable picture of the Distributor. In the 1983 A.M.-peak period, the Distributor was roughly 15% more efficient than THE RIDE; in the P.M. peak the Distributor was about 20% more efficient. However, the Distributor caused a 100% degradation in service for an average linked core-periphery trip, by doubling the average travel time required to complete it, using THE RIDE. Linked trips represented roughly 65% of all trips executed on the Distributor. Thus, average peak-period benefits in productivity of roughly 18% were purchased at the cost of a 100% degradation of service to 65% of the Distributor's market. (The Distributor directly affected 11% and 12% of all scheduled passenger trips in September 1982 and September 1983, respectively.) These data argue that the costs far exceeded the benefits provided.



Vehicle-hours do not include deadheading time.

Special-Needs Transportation Evaluation Technical Report 53a September 1985	VEHICLE PRODUCTIVITY --NON-DISTRIBUTOR VEHICLES	CTPS FIGURE 4-3

		No. of Veh-Hrs of Service, 5 Weekdays	No. of Pax-Trips, 5 Weekdays	Average Veh Prod'ty, (Pax-Trips/Hr.)
AM Peak	1982	25	73	2.92
Off-Peak	1982	60	46	0.77
PM Peak	1982	25	62	2.48
AM Peak	1983	25	71	2.84
Off-Peak	1983	60	63	1.05
PM Peak	1983	25	61	2.44

Note: The no. of vehicle-hours (veh-hr) served which is used in this table is estimated by the following formula:
AM Peak: 2.5 hrs/day x 2 veh x 5 days/wk = 25 veh-hr/wk
Off-Peak: 6.0 hrs/day x 2 veh x 5 days/wk = 60 veh-hr/wk
PM Peak: 2.5 hrs/day x 2 veh x 5 days/wk = 25 veh-hr/wk

The number of scheduled pax-trips has been adjusted by giving Class 2 trips a value of one-half, and decreasing the total number of trips per period accordingly.

		No. of Veh-Hrs of Service, 5 Weekdays	No. of Pax-Trips, 5 Weekdays	Average Veh Prod'ty, (Pax-Trips/Hr.)
AM Peak	1982	150	406	2.71
Off-Peak	1982	360	605	1.68
PM Peak	1982	188	414	2.20
AM Peak	1983	188	463	2.46
Off Peak	1983	460	776	1.69
PM Peak	1983	225	456	2.03

Note: The no. of vehicle-hours (veh hr) served which is used in this table is estimated by the following formula:

1982:

AM Peak: 2.5 hrs/day x 12 veh x 5 days/wk = 150 veh-hr/wk
Off Peak: 6.0 hrs/day x 12 veh x 5 days/wk = 360 veh-hr/wk
PM Peak: 2.5 hrs/day x 15 veh x 5 days/wk = 187.5 veh-hr/wk

1983:

AM Peak: 2.5 hrs/day x 15 veh x 5 days/wk = 187.5 veh hr/wk
Off-Peak: 6.0 hrs/day x 15.3 veh x 5 days/wk = 459.9 veh-hr/w
PM Peak: 2.5 hrs/day x 18 veh x 5 days/wk = 225 veh-hr/wk

The number of scheduled pax-trips has been adjusted by giving Class 2 trips a value of one-half, and decreasing the total number of trips per period accordingly.

5 OPERATION OF THE DOWNTOWN DISTRIBUTOR

How the Distributor functioned was investigated using data from passenger logs and from the survey of users. Because two vehicles per day were dedicated to Distributor use, two vehicle logs per day were available for analysis. The vehicle logs from five days in September 1982 and five days in September 1983 were examined. For a complete discussion of the method used in the user survey, see the CTPS technical report, Special Needs Transportation Evaluation: Analysis of the Special Needs Users Transportation Survey (to be published following the present report).

The Downtown Distributor was designed to operate as a modified fixed-route bus service. It differed from typical fixed-route bus services in that telephone reservations were accepted, and eligible riders could, in theory, flag down the buses anywhere along the two routes that were created within downtown Boston. The Distributor was supposed to operate on a fixed time schedule.

There is evidence in both the passenger logs and the survey responses of significant differences between how the Distributor was intended to operate and how it in fact operated. This evidence corroborates users' informal claims that they could not rely on the distributor to always operate as it was supposed to.

The 1982 sample passenger logs indicate that one of the ten Distributor vehicles stopped for a protracted period of time when it was supposed to be on its scheduled tour. The 1983 sample logs indicate that three of the ten Distributor vehicles stopped for prolonged periods during the afternoon. These findings correlate with findings of the user survey.

The survey results indicated that many Distributor users had difficulty in flagging down a vehicle along the Distributor routes. The results also indicated that 90% of the respondents using the Downtown Distributor made telephone reservations for that service.

In analyzing these findings, there is not conclusive evidence available for determining if the failure of some Distributor vehicles to make all of their tours was the primary cause of patrons' heavy reliance on telephone reservations, or if the reverse occurred. However, the actual operation of the Distributor appears to have at least eventually contributed to its use as a modified, demand-responsive service. From many

users' perspectives, it was necessary to make service reservations in advance. Regardless of the cause, the apparent result was that the Distributor functioned in much the same way as THE RIDE--as a demand-responsive, advance-reservation service--but on a fixed route.

The MBTA's and the users' evaluations of this outcome differed substantially. From the MBTA's position, fixed-route bus service downtown may have appeared to function fairly well. It provided the service it was designed to deliver most of the time, while requiring fewer vehicles than had THE RIDE--which implied lower operating costs.

From the user's point of view, using the Distributor usually entailed at least as much inconvenience as THE RIDE, but none of the benefits. Advance reservations had to be made to guarantee a trip, which meant planning trips relatively far in advance and incurring the expense (in terms of the users' time) of the phone reservation process. Yet users could not be guaranteed door-to-door service on the Distributor. In addition, if a user was traveling between the core and periphery, he or she was required to make a vehicle transfer and was faced with an average out-of-vehicle wait of 15 minutes. Altogether, average travel time was double that which would have been required with the previously existing RIDE service.

6 OPERATIONAL IMPLICATIONS OF ELIMINATING THE DOWNTOWN DISTRIBUTOR

Given the substantial costs and limited benefits of the Distributor that have become apparent over the course of this study, it is logical to ask what might be the ramifications of eliminating the Distributor and returning to an all-RIDE system.

If the Distributor were eliminated:

1. The average productivity of RIDE vehicles could be expected to decline;
2. Vehicle transfers (linked trips) would be eliminated.

Both changes would be likely to affect the number of passenger-trips delivered. The degree of the separate effects of the two changes and of their aggregate effect is estimated in this chapter.

6.1 EFFECT OF DECLINE IN AVERAGE RIDE-VEHICLE PRODUCTIVITY

The expectation that vehicle productivity would fall if the Distributor were eliminated is based on the changes wrought by the Distributor's introduction. During September 1982--six months after Distributor service began--vehicle productivity on dedicated RIDE vehicles was higher than it had been during September 1981. It is likely that this rise in vehicle productivity was caused by the Distributor. Conversely, elimination of the Distributor would be likely to cause a decline in productivity.

This decline in RIDE vehicle productivity would be likely to affect peak periods only. This limitation of the effect is expected because if is assumed that vehicle capacity during the 1982 service change was constrained. That is to say, the increase in RIDE vehicle productivity seen in 1982--and attributed to the Distributor's implementation--could have happened only if RIDE vehicles were operating at or near capacity at the time of the service change. Such a capacity constraint applied only to the peak-period vehicles--the data indicate that excess capacity characterized the daytime off-peak period. Thus, the decline in vehicle productivity which would accompany the Distributor's elimination would affect peak-period travel only.

An estimate of the probable effect on September 1984 productivity that would result from eliminating the Distributor can be made as follows. During an average weekday in September 1984, 21 vehicles

operated for 2.5 hours during the A.M. peak, and 26 vehicles operated for 2.5 hours during the P.M. peak. The probable decrease in passenger-trips for each period can be calculated using the following equations (in which "A.M." stands for "A.M. Peak" and "P.M." for "P.M. Peak"):

A.M.-Passenger-Trip Decline

= A.M. Veh. Productivity Loss x No. of A.M. RIDE Veh.-Hrs.
= ($A.M._{1982}$ - $A.M._{1981}$) x (No. of A.M. Vehs. x No. of A.M. Hrs.)
= (2.71 - 2.68 Pass.-Trips/Veh.-Hr.) x (21 veh. x 2.5 hrs.)
= (0.03 Pass.-Trips/Veh.-Hr.) x (52.5 Veh.-Hrs.)
= 1.58 Pass.-Trips

P.M. Passenger Trip Decline

= P.M. Veh. Productivity Loss x No. of P.M. RIDE Veh.-Hrs.
= ($P.M._{1982}$ - $P.M._{1981}$) x (No. of P.M. Vehs. x No. of P.M. Hrs.)
= (2.20 - 2.17 Pass.-Trips/Veh.-Hr.) x (26 veh. x 2.5 hrs.)
= (0.03 Pass.-Trips/Veh.-Hr.) x (65.0 Veh.-Hrs.)
= 1.95 Pass.-Trips

Thus, the decline in average productivity of RIDE vehicles that could reasonably be expected to result from eliminating the Distributor would cause a decline in passenger-trips per weekday of 1.58 plus 1.95, or roughly 3.5.

6.2 EFFECT OF ELIMINATION OF LINKED TRIPS

Eliminating the Distributor would also do away with linked trips. These trips could be provided by THE RIDE, with no significant increase in the amount of vehicle-operating time required to do so.[1] In January 1984 the Distributor was modified so as to operate only during the morning and afternoon peak periods. This service change greatly reduced passengers' core-periphery travel times and increased their demand for core-periphery travel during the off-peak period. Thus, the off-peak passenger benefit to be wrought from eliminating the Distributor has largely been gained, and the Distributor's complete elimination is not likely to further affect the demand for daytime off-peak travel in a significant way. Peak-period vehicle productivity is unlikely to be affected, because peak-period demand has been assumed to be capacity constrained.

6.3 AGGREGATE EFFECT

In the aggregate, ending Distributor service and returning to an all-RIDE system would produce the following results:

Reduced Veh. Productivity on THE RIDE:	- 3.5 pass.-trips/day
Elimination of Linked Trips:	0 pass.-trips/day
	- 3.5 pass.-trips/day

Aggregate Loss: 3.5 pass.-trips/day

Thus, eliminating the Distributor would be likely to produce a small decrease in the number of passenger-trips per day. As a consequence, vehicle productivity would decline, but almost imperceptibly. To the degree that vehicle productivity is a measure of system efficiency, efficiency would be effectively unchanged by abandoning the Distributor.

If the assumptions used in this analysis were found to be either high or low, it would still be unlikely that the aggregate passenger-trip gain or loss resulting from the Distributor's elimination would exceed 5 or--at most--10 passenger-trips per day. Given that at present THE RIDE provides roughly 500 passenger-trips per day, this scale of change would imply a 1% or 2% gain or loss in daily passenger-trips, which would not significantly alter the RIDE's overall performance.

NOTE TO CHAPTER 6

[1]The incremental vehicle-operating time required to serve current linked trips as direct trips can be estimated using the following assumptions. Average core-periphery passenger-trip time declined by 0.7 minutes (or 42 seconds) between 1981 and 1982, due to the Distributor's implementation. Thus, average core-periphery trip time could be expected to increase by 0.7 minutes if the Distributor were eliminated.

The September 1984 sample data indicate that an average of 12.4 linked trips are completed daily. All of these passenger-trips occur in the peak periods (off-peak Distributor service was discontinued in January 1984). Therefore, Incremental Time Required to serve current Linked Trips as Direct Trips.

= 12.4 Passenger Trips/Day x 0.7 Minutes/Passenger Trip
= 8.68 Minutes/Day

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

Six major conclusions can be drawn from the preceding analyses:

- THE RIDE and Downtown Distributor services began most of their scheduled trips on time.

  Between 55% and 60% of all passenger-trips began exactly on time. The MBTA considers a pick-up to be "on time" when it is made within ten minutes, either way, of the scheduled pick-up time. By this criterion, 85% of all completed passenger-trips started "on time."

- The Downtown Distributor did not operate as fixed-route bus service. Rather, it operated much like THE RIDE, but with service limited to the Distributor routes.

  The Distributor was designed to provide fixed-route bus service along two routes located completely within the downtown. Telephone reservations were not necessary, but they could be made. Users were supposed to be able to signal for service by waving down the vehicle anywhere along either route.

  In practice, 90% of the users reserved service by phone. Sometimes a Distributor vehicle did not make its appointed tours during a portion of the day--usually in the afternoon. These behaviors reinforced each other, resulting in the Distributor service's functioning in much the same way as THE RIDE.

- RIDE-system efficiency, as measured by general vehicle productivity, was not significantly affected by the Distributor's implementation.

  The MBTA's goal in implementing Distributor service was to enhance system productivity. Productivity remained more or less the same during the first two years of the Distributor's operation. However, the Distributor operated significantly more efficiently during peak periods than in the daytime off-peak. In 1983, average peak-period vehicle productivity, measured in passenger-trips per vehicle-mile, was 18% higher on the Distributor than on THE RIDE. By contrast, during the off-peak period, the Distributor was 38% less efficient than THE RIDE.

- The Distributor increased average trip time by 100% for core-periphery trips (which made up roughly 65% of the Distributor's 1983 passenger-trips), while periphery-periphery trip time decreased marginally after the Distributor's implementation. As a result, core-periphery travel decreased and periphery-periphery travel increased.

  Prior to the start of Distributor service, core-periphery trips made up 34% of all trips. During the first year of Distributor operation, they declined to 29%; during the second, to 25%. In this same two-year period, the number of periphery-periphery trips--trips unaffected by the Distributor--increased by 9%.

- Eliminating the Downtown Distributor would probably precipitate a small decrease in the number of passenger-trips which could be scheduled daily (roughly 5 passenger-trips per day). This decline would be unlikely to produce a perceptible change in systemwide vehicle productivity. To the degree that vehicle productivity is a measure of system efficiency, efficiency would be effectively unchanged by the Distributor's elimination.

  RIDE-vehicle productivity during the peak periods was marginally improved by the implementation of Distributor service. The decrease in peak-period vehicle productivity that would result from eliminating the Distributor would amount to 5 or--at most--10 passenger-trips per day. This scale of loss would imply a 1% or 2% decrease in the number of passenger-trips scheduled daily, which would not significantly affect the service's overall performance.

- The MBTA's decision (implemented in January 1984, during the preliminary stages of this study) to discontinue Distributor service during off-peak hours is supported by the findings of this study.

  Operation of Distributor service during the off-peak period detracts from overall vehicle productivity. Off-peak travel can be provided more efficiently by THE RIDE than by the Distributor. THE RIDE also provides users with a much higher level of service.

7.2 RECOMMENDATIONS

The primary finding of this study is that serious consideration should be given to discontinuing the Downtown Distributor altogether.*

Analysis of RIDE and Distributor operations indicates that a few less passenger-trips per day could be adequately scheduled were

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*Downtown Distributor service was, in fact, discontinued in May 1985, when this report was in draft form.

the Distributor to be eliminated. However, this decrease would be so small relative to the current service demand that RIDE vehicle productivity would be effectively unchanged.

The principal operational benefit of abandoning the Distributor would be a 50% reduction in travel time for core-periphery trips, which would result from elimination of vehicle transfers. This improvement would be likely to bring about an increase in peak-period, core-periphery trips, which decreased after implementation of the Distributor.

APPENDIX A

SAMPLE DAILY PASSENGER LOG

DAILY PASSENGER LOG ( )

SERIAL # ____ VEH # 24 DATE 09/24/84

ST TIME ____ FIN TIME ____ TOT TIME ____

ST. MILE 88151 FIN. MILE. ____ TOT. MILE ____

DRIVER #1 FRANKLIN #2 ____

	SCH TIME	CODE NO.	NAME	ORIGIN		DESTINATION		ATN	NRP	GRP	TRIP MILEAGE BEGIN	END	TOT	TRIP TIME BEGIN	END	TOT	TRIP PURPOSE MED	EMP	TRN	NTR	SOC	SHP	EDU	HMH	OTH	Fare AGN	IND	Type SUB	IMM	ADV	REMARKS
7	07 00		ADAM ANT	30 WASH. ST.	02	ST FELIX HOSP	02				160	161		700	718											3			✓	
8	08 00	12	JOE BLOW	LEGAL SEAFOOD	08	YOUVILLE HOSP	08	✓			167	169		800	815											6			✓	
		12	MOLLY MUFFIN	" "	08	STADIUM WAY	08				167	171		800	830											3			✓	
9		12	BILBO BAGGINS	FRESH POND MALL	08	25 MISSION PK DR	04				174	180		900	925											3			✓	
		12	ARTHUR, KING	" " "	08	50 PEMBROKE ST	06				174	182		900	940											6			✓	
10	10 30	12	PAULINE DE LAPISSONIER	MUSEUM, FINE ART	04	150 HUNTING AVE	04	✓			187	190		1030	1045											6			✓	
11																														
12	12 30	22	LUCREZIA BORGIA	1055 COMM AVE	01	40 WILLIAMS ST	03				197	198		1230	1235											3			✓	
	12 30	22	CAPPELLINI MEDICI	" " "	01	34 KNAPP ST	03				197	199		1230	1240											3			✓	
	12 30	22	ANASTASIA ROMANOFF	" " "	01	60 FRANKLIN ST	03				197	201		1230	1250											3			✓	
TOTALS																														

APPENDIX B

DATA USED IN PREPARING SELECTED FIGURES

Time Period	Factored Distrib. of Scheduled Trips		
	Sept. 1981	Sept. 1982	Sept. 1983
6 : 00 - 6 : 59	8	97	4
7 : 00 - 7 : 59	1016	1055	1119
8 : 00 - 8 : 59	737	583	753
9 : 00 - 9 : 59	479	471	601
10 : 00 - 10 : 59	598	467	593
11 : 00 - 11 : 59	500	425	644
12 : 00 - 12 : 59	766	529	733
13 : 00 - 13 : 59	532	568	725
14 : 00 - 14 : 59	594	510	616
15 : 00 - 15 : 59	905	699	959
16 : 00 - 16 : 59	913	1113	1186
17 : 00 - 17 : 59	684	630	725
18 : 00 - 18 : 59	180	220	148
19 : 00 - 19 : 59	147	108	98
20 : 00 - 20 : 59	61	58	43
21 : 00 - 21 : 59	106	54	74
22 : 00 - 22 : 59	33	39	35
23 : 00 - 23 : 59	4	0	4
24 : 00 - 24 : 59	0	0	4
TOTAL	8265	7626	9064

Special-Needs Transportation Evaluation	DISTRIBUTION OF SCHEDULED TRIPS BY TIME OF DAY TOTAL TRIPS FOR EACH: SEPTEMBER 1981, SEPTEMBER 1982, AND SEPTEMBER 1983	CTPS
Technical Report 53a September 1985		TABLE B-1

Travel Period	%	1	%	2	%	3*
1981						
AM Peak	1.934	159.8	0	0	10.16	840.4
Off Peak	1.091	90.19	0	0	12.5	1033.
PM Peak	1.984	163.9	0	0	9.573	791.2
Evening	0	0	0	0	1.884	155.7
Total		414.0		0		2820.
1982						
AM Peak	2.118	152.3	0.923	66.42	8.636	621.2
Off Peak	1.086	78.14	2.661	191.4	5.268	378.9
PM Peak	1.412	101.5	2.281	164.0	6.898	496.2
Evening	0.543	39.07	0	0	1.466	105.4
Total		371.1		421.9		1601.
1983						
AM Peak	1.435	121.0	1.713	144.4	6.160	519.1
Off Peak	1.250	105.3	3.751	316.1	3.473	292.7
PM Peak	1.713	144.4	2.084	175.6	7.040	593.3
Evening	0	0	0	0	1.065	89.78
Total		370.8		636.2		1495.

Note: Class 1 trips are core-core
Class 2 trips are linked core-periphery
Class 3 trips are direct core-periphery
Class 4 trips are periphery-periphery

Special-Needs Transportation Evaluation	FACTORED DISTRIBUTION OF RIDE TRIPS BY TRAVEL PERIOD AND BY CLASS TRIP	CTPS
Technical Report 53a September 1985		TABLE B-2A

Travel Period	%	4	%	2&3+	Total
1981					
AM Peak	12.79	1057.	10.16	840.4	2058.
Off Peak	29.81	2463.	12.5	1033.	3587.
PM Peak	13.69	1131.	9.5??	791.2	2086.
Evening	4.56?	377.1	1.884	155.7	532.9
Total		5030.		2820.	8265
1982					
AM Peak	14.28	1027.	9.560	687.6	1867.
Off Peak	30.79	2215.	7.930	570.4	2863.
PM Peak	16.89	1215.	9.179	660.3	1977.
Evening	4.725	339.9	1.466	105.4	484.4
Total		4797.		2023.	7193
1983					
AM Peak	15.37	1296.	7.874	663.6	2080.
Off Peak	35.94	3029.	7.225	608.9	3743.
PM Peak	15.28	1288.	9.124	769.0	2201.
Evening	3.705	312.2	1.065	89.78	402.0
Total		5925.		2131.	8428

Note: 1982 and 1983 Class 3 trips represent net trips, i.e. 1982 and 1983 Class 2 trips, respectively, have been subtracte from total Class 3 trips to compensate for the double counting of Class 2 trips.

Special-Needs Transporation Evaluation	FACTORED DISTRIBUTION OF RIDE TRIPS BY TRAVEL PERIOD AND BY CLASS TRIP	CTPS
Technical Report 53a September 1985		TABLE B-2B

Purpose	1981	1982	1983	Total
Medical:	221	167	228	616
(%)	11.03	9.324	11.01	10.50
Employment:	430	421	447	1298
(%)	21.46	23.50	21.60	22.13
Social:	222	182	206	610
(%)	11.08	10.16	9.956	10.40
Education:	104	96	88	288
(%)	5.192	5.360	4.253	4.912
Home:	960	896	1041	2897
(%)	47.92	50.02	50.31	49.41
Other:	66	29	59	154
(%)	3.295	1.619	2.851	2.626
TOTAL	2003	1791	2069	5863

Percentages are per cent of column totals.

Class 1 trips are core-core
Class 2 trips are linked core-periphery
Class 3 trips are direct core-periphery
Class 4 trips are periphery-periphery

*Note:

1982 and 1983 Class 3 trips represent net trips, i.e. 1982 and 1983 Class 2 trips, respectively, have been subtracted from Total Class 3 trips to compensate for the double counting of Class 2 trips.

Special-Needs Transportation Evaluation	DISTRIBUTION OF ALL RIDE TRIPS BY TRIP PURPOSE BY YEAR	CTPS
Technical Report 53a September 1985		TABLE B-3

Class	Sept. 1981	Change (%)	Sept. 1982	Change (%)	Sept. 1983
1	2.04	-0.7 -34.3	1.34	0.39 29.10	1.73
2	0	1.7 ERR	1.7	-0.13 -7.64	1.57
3	5.45	-0.4 -7.33	5.05	-0.39 -7.72	4.66
4	4.19	-0.29 -6.92	3.9	0.05 1.282	3.95
Avg. All Classes	4.5	-0.51 -11.3	3.99	-0.12 -3.00	3.87

Special-Needs Transportation Evaluation	AVERAGE TRIP LENGTH (FROM DATA ON COMPLETED TRIPS) BY YEAR AND CHANGES BETWEEN YEARS	CTPS
Technical Report 53a September 1985		TABLE B-4

	1981	1982	1983
Class 1			
Travel Time	16.7	17.9	22.9
Wait Time	NA	0	0
Total	16.7	17.9	22.9
Class 2			
Dntn Trvl Time	0	19.5	18.2
NonD Trvl Time	0	29.8	29.1
Wait Time	0	15	15
Total	0	64.3	62.3
Class 3	30.5	29.8	29.1
Class 4	23.9	22.8	23.4

Special-Needs Transportation Evaluation	AVERAGE TRIP TIME (IN MINUTES) FOR ALL TRIPS BY CLASS AND BY YEAR (No waiting time added for Class 1 trips in 1982 or 1983)	CTPS TABLE B-5
Technical Report 53a September 1985		

APPENDIX C

MONTHLY RIDERSHIP BY TRIP ORIGIN-DESTINATION CHARACTERISTICS

Monthly Ridership on THE RIDE and the Downtown Distributor by Origin-Destination Characteristics

As described in section 2, all trips in the sample data were classified as belonging to one of four trip classes. These trip classes were organized by their origin-destination characteristics.

To reiterate the connection between trip class and type of service provided, Class 1 (core-core), 3 (direct core-periphery) and 4 (periphery-periphery) trips were all provided by THE RIDE in 1981. In 1982 and 1983 Class 1 and 2 (linked core-periphery) trips were provided by the Distributor, while Class 3 and 4 trips were provided by THE RIDE.

Monthly ridership on THE RIDE and the Downtown Distributor was not reported separately for each service in 1981, 1982 and 1983. Rather, all scheduled RIDE and Distributor trips were reported in one monthly aggregate figure. Monthly ridership figures had to be factored from the data available.

The factoring of all scheduled passenger trips in September 1981, September 1982 and September 1983 was based on the distributions observed in the sample data.[1] For each of the three data samples, the number of scheduled passenger trips per trip class was established by a simple sorting. Within each sample, the number of scheduled passenger trips per class was divided by the number of trips in all classes, producing a percentage distribution by trip class. Thus, the product of the number of scheduled trips

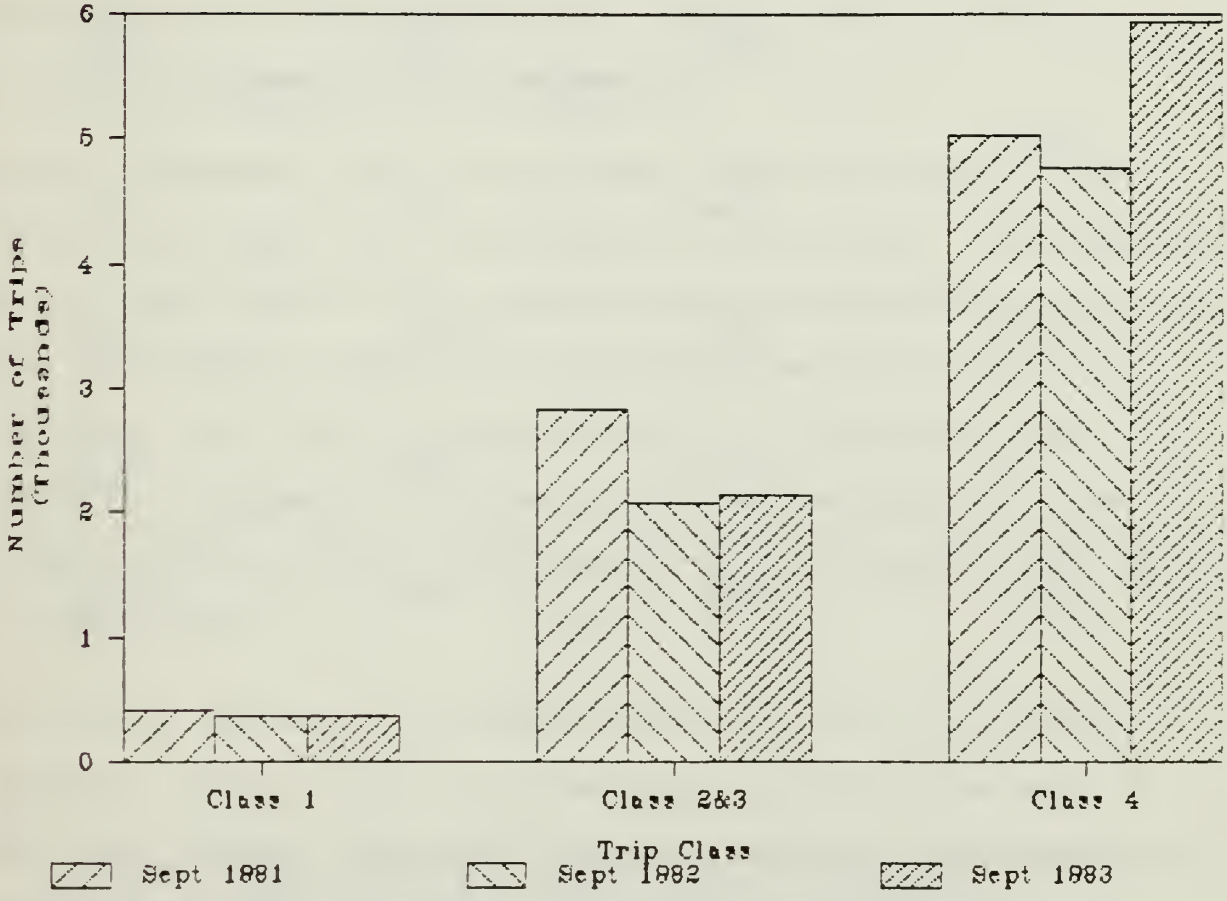
provided in September 1982, for example, by the percentage distribution of trips by trips class in that month, estimated the number of Class 1, 2, 3, and 4 trips provided in September 1982. Estimation of the September 1981 and September 1983 distributions was performed in a similar way.

The substance of this section parallels the discussion in section 3.1. That discussion focused on the sample data alone. This discussion focuses on the delivery of RIDE and Distributor services at the monthly level.

Figure C-1 shows a plot of Projected Monthly Scheduled Trips in September of each 1981, 1982 and 1983. The data from which this plot was derived are presented in Table C-1.

As noted earlier, it is logically consistent to compare 1981 Class 3 (direct core-periphery) trips with the sum of Class 2 and Class 3 trips, i.e., all core-periphery trips, both linked and direct, in 1982 and 1983. This has been done in Figure 1. A second graph of Projected Monthly Scheduled Trips for each of the four trip classes separately is presented in Appendix D.

It can be inferred from the data in Figure 1 that during the 1981-1982 period--the period of the Distributor's implementation--there was a general decline in the number of scheduled passenger trips. However, the relative decline in all scheduled core-periphery (Class 2 plus Class 3) trips was far greater than that of other classes.



Special-Needs Transportation Evaluation Technical Report 53a September 1985	PROJECTED MONTHLY SCHEDULED TRIPS (Adjusted and Factored fm Weekly Data)	CTPS FIGURE C-1

Class	Sept. 1981	Change (%)	Sept. 1982	Change (%)	Sept. 1983
1	414	-11.4	367	1.1	371
2&3	2818	-26.8	2063	3.2	2129
4	5034	-5.4	4763	24.5	5928
Total	8266	-13.0	7193	17.2	8428

Note: In the above table, the number of Class 3 trips represents the old Class 3 trips, Class 3*, minus Class 2 trips, to compensate for the double-counting of linked trips in Class 3*.

Special-Needs Transportation Evaluation	PROJECTED MONTHLY SCHEDULED TRIPS (ADJUSTED AND FACTORED FROM WEEKLY DATA) BY YEAR AND CHANGES BETWEEN YEARS	CTPS
Technical Report 53a September 1985		TABLE C-1

If one compares September 1981 against September 1982, the number of scheduled trips for all trip classes declined 13%, from 8270 to 7190 trips. In this same period vehicle-hours of service declined from 4449 September 1981) to 4245 vehicle-hours (in September 1982), or 4.6%. Thus, the 13% decline in all scheduled passenger trips reflects somewhat the 4.6% decline in the number of scheduled vehicle-hours of service.

Between September 1981 and September 1982 the number of Class 1 (core-core) trips fell 11%, from 410 to 370 trips. The number of Class 2 plus Class 3 (all core-periphery) scheduled trips fell by 27%, from 2820 to 2060 trips. It should be noted that core-periphery trips were directly affected by the Distributor. By contrast, the number of Class 4 (periphery-periphery) trips--trips unaffected by the Distributor--fell by only 5%, from 5030 to 4760 trips.

These data document a disproportionate decline in all core-periphery trips, relative to the other kinds of trips made in the 1981-1982 period. Beside the general decline in vehicle-hours of service available, the start of Distributor service was the only other significant service change to occur between 1981 and 1982. The general reduction in service explains some of the decline in scheduled trips across all trip classes; but the differential impacts described above can reasonably be attributed to the Distributor.

Comparing September 1982 against September 1983, all scheduled trips increased by 17%; there were 8430 trips scheduled during

September 1983. The number of Class 1 (core-core) trips increased by 1%, from 365 to 370 trips. The number of Class 2 plus Class 3 (all core-periphery) scheduled trips increased by 3%, to a 1983 level of 2130 trips. The number of scheduled Class 4 (periphery-periphery) trips increased by 24%, to a 1983 level of 5930 trips.

The strong difference between the increase in periphery-periphery (Class 4) trips vis a vis the increase in core-periphery (Class 2 plus Class 3) trips indicates a disproportionate gain of periphery-periphery trips relative to core-periphery trips, a gain which is at least partially attributable to the Distributor.

These statistics document systematic changes in the pattern of service delivery. But, one set of statistics in isolation offers only a partial explanation of why these changes occurred. A broader interpretation of the facts is attempted in the following paragraphs.

The start of Distributor service systematically changed users' travel costs, making travel between the downtown and peripheral areas (Class 2 plus Class 3 trips) relatively more costly than travel completely in peripheral areas (Class 4 trips). Class 2 plus Class 3 average trip time increased 110% between 1981 and 1982. Class 4 trip time decreased by 5%. This basic shift in the distribution of travel costs continued into 1983. Average Class 2 plus Class 3 (all core-periphery) trip time in 1983 was 104% higher than a comparable trip in 1981. And average Class 4

(periphery-periphery) trip time was 2% lower in 1983 than in 1981.

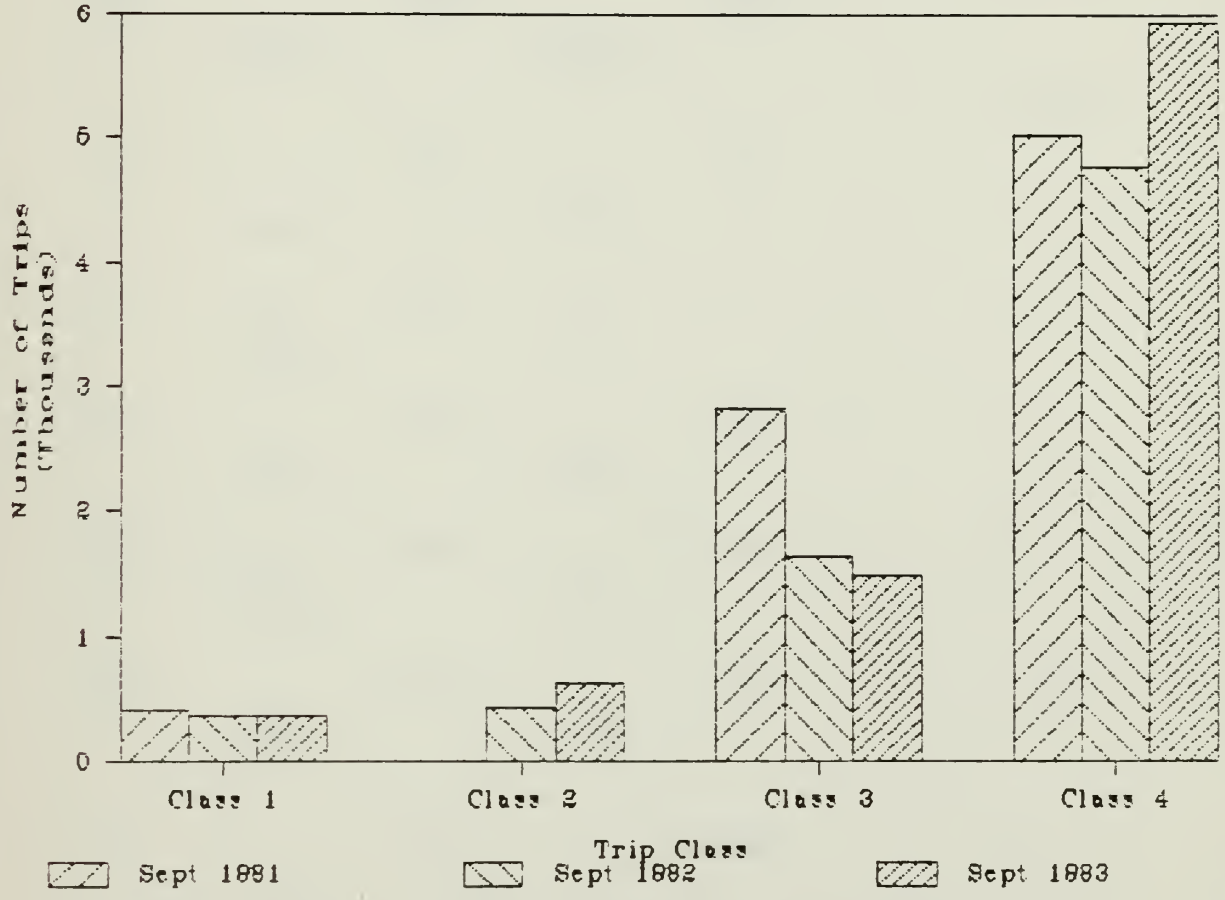
These changes in user cost precipitated a re-alignment in the pattern of trip-making: travel between the downtown and the periphery declined to the benefit of periphery to periphery trips. In the 1981-1983 interval, core-core (Class 1) trips as a percentage of all trips were basically unchanged. All core-periphery (Class 2 plus Class 3) trips went from 34% of all scheduled trips to 25%, and periphery-periphery (Class 4) trips went from 61% to 70%.

---

[1]Because each sample size was large, the percentage distribution of trips by trip class was assumed to be representative of each month's true distribution.

APPENDIX D

GRAPH OF MONTHLY RIDERSHIP BY TRIP ORIGIN-DESTINATION CHARACTERISTICS



Special-Needs Transportation Evaluation Technical Report 53a September 1985	PROJECTED MONTHLY SCHEDULED TRIPS (Adjusted and Factored fm Weekly Data)	CTPS FIGURE D-1

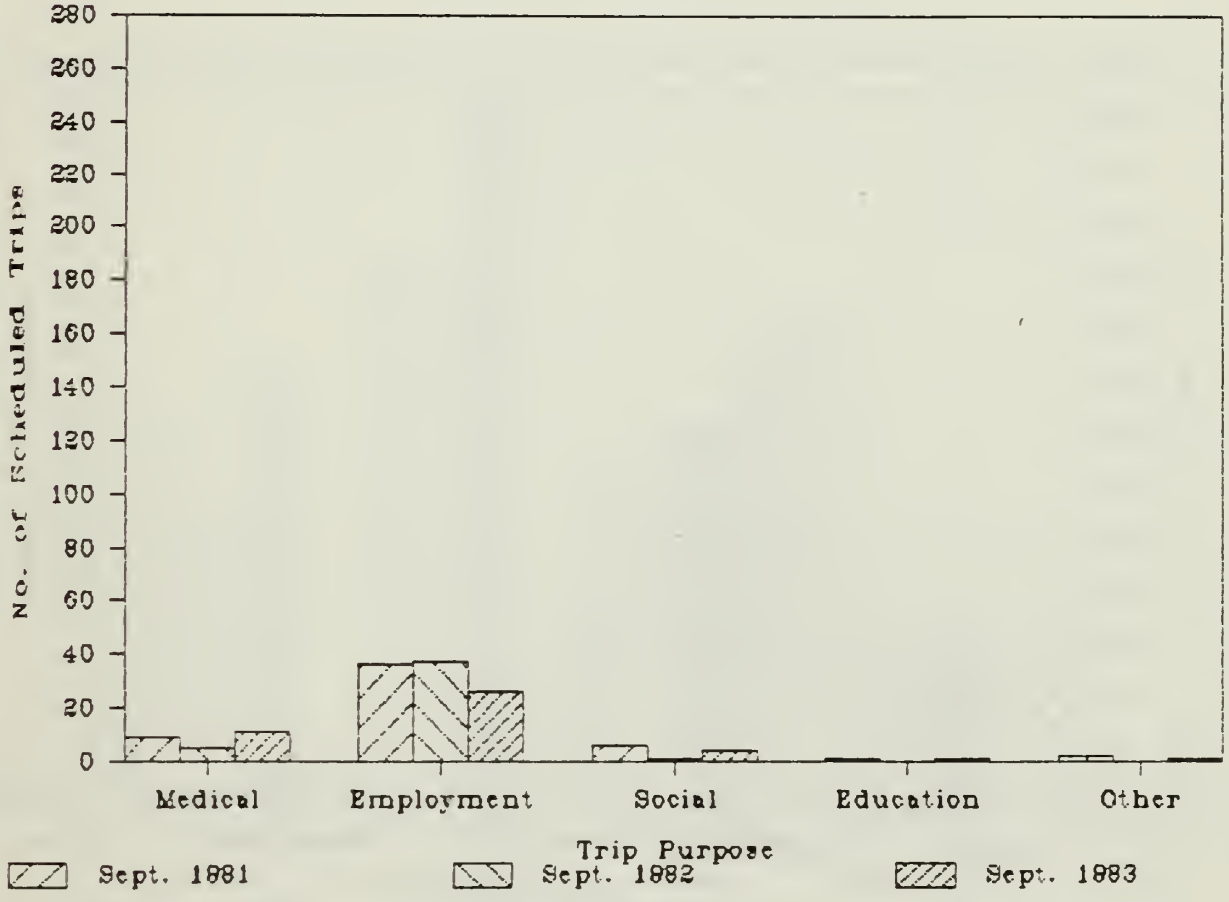
Class	Sept. 1981	Change (%)	Sept. 1982	Change (%)	Sept. 1983
1	414	-47 -11.3	367	4 1.089	371
2	0	433	433	203 46.88	636
3	2818	-1188 -42.1	1630	-137 -8.40	1493
4	5034	-271 -5.38	4763	1165 24.45	5928
Total	8266	-1073 -12.9	7193	1235 17.16	8428
3*	2818		2063		2129

Note: In the above table, the number of Class 3 trips represents the old Class 3 trips, Class 3*, minus Class 2 trips, to compensate for the double-counting of linked trips in Class 3*.

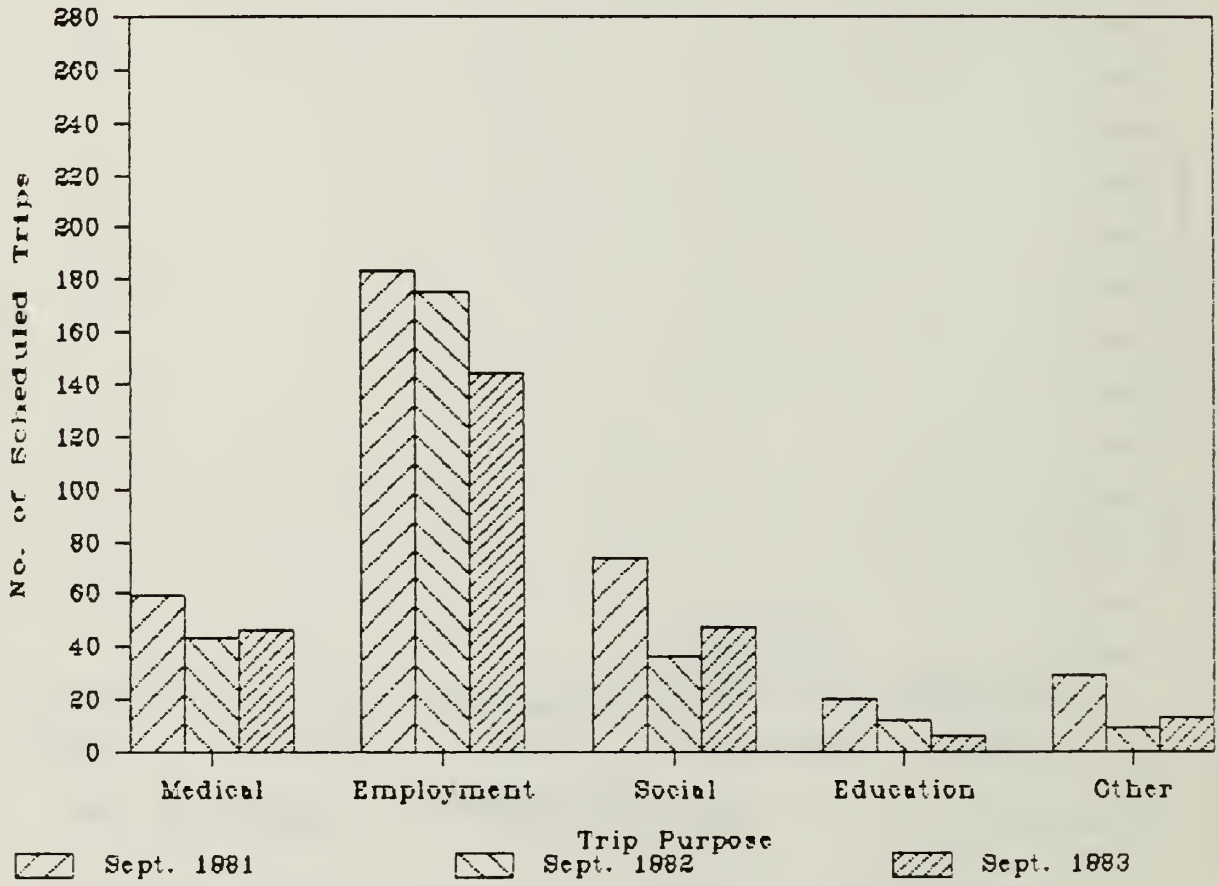
Special-Needs Transportation Evaluation Technical Report 53a September 1985	PROJECTED MONTHLY SCHEDULED TRIPS (ADJUSTED AND FACTORED FROM WEEKLY DATA) BY YEAR AND CHANGES BETWEEN YEARS	CTPS TABLE D-1

APPENDIX E

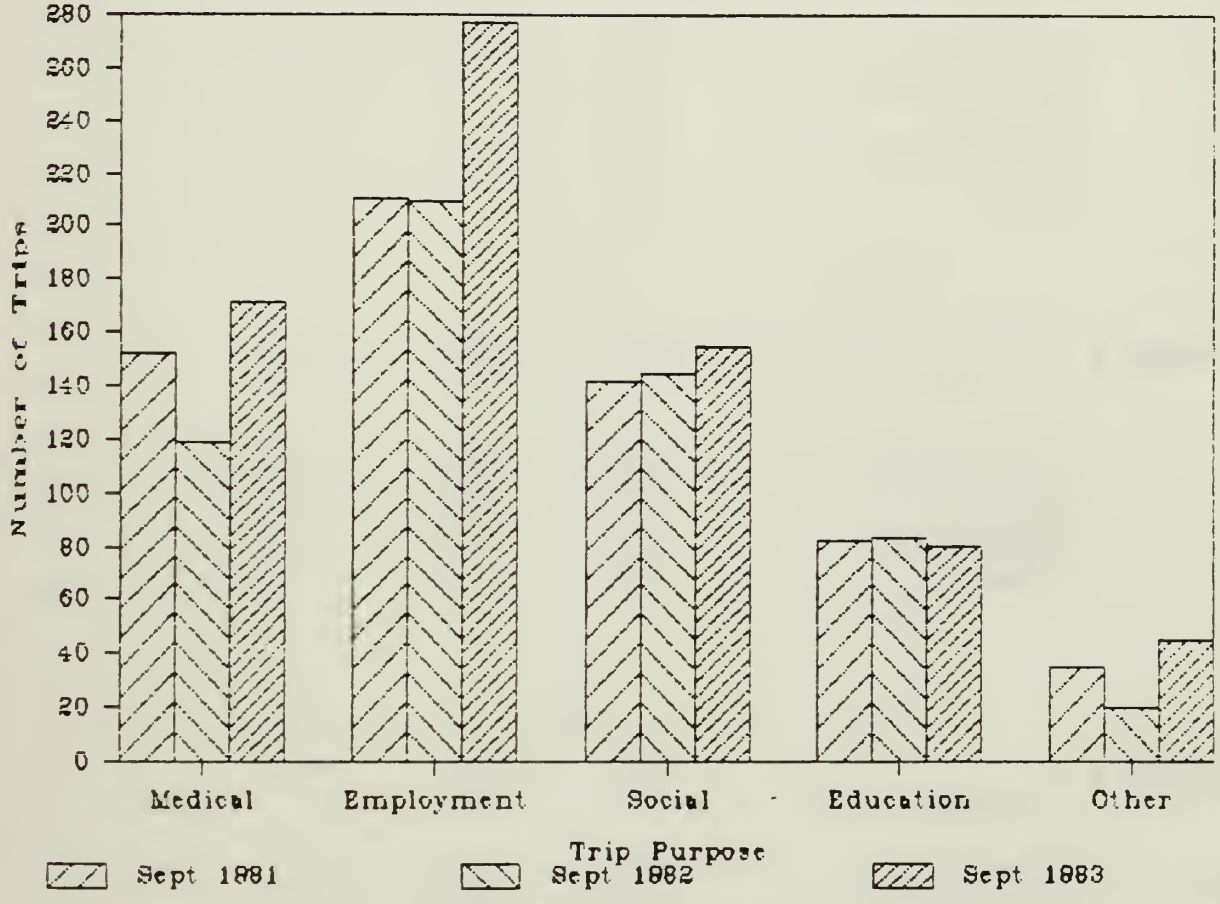
TRIP PURPOSE BY TRIP ORIGIN-DESTINATION CHARACTERISTICS



Special-Needs Transportation Evaluation	CLASS 1 TRIPS BY PURPOSE	CTPS FIGURE E-1
Technical Report 53a September 1985		



Special-Needs Transportation Evaluation Technical Report 53a September 1985	CLASS 2 & 3 TRIPS BY PURPOSE	CTPS FIGURE E-2



Special-Needs Transportation Evaluation Technical Report 53a September 1985	CLASS 4 TRIPS BY PURPOSE	CTPS FIGURE E-3

CLASS 1 Purpose	1981	1982	1983
Medical	9	5	11
Employment	36	37	26
Social	6	1	4
Education	1	0	1
Other	2	0	1

CLASS 2 Purpose	1981	1982	1983
Medical	0	1	12
Employment	0	9	43
Social	0	1	11
Education	0	0	1
Other	0	1	6

CLASS 3 Purpose	1981	1982	1983
Medical	60	42	34
Employment	183	166	101
Social	74	35	36
Education	20	12	5
Other	29	9	13

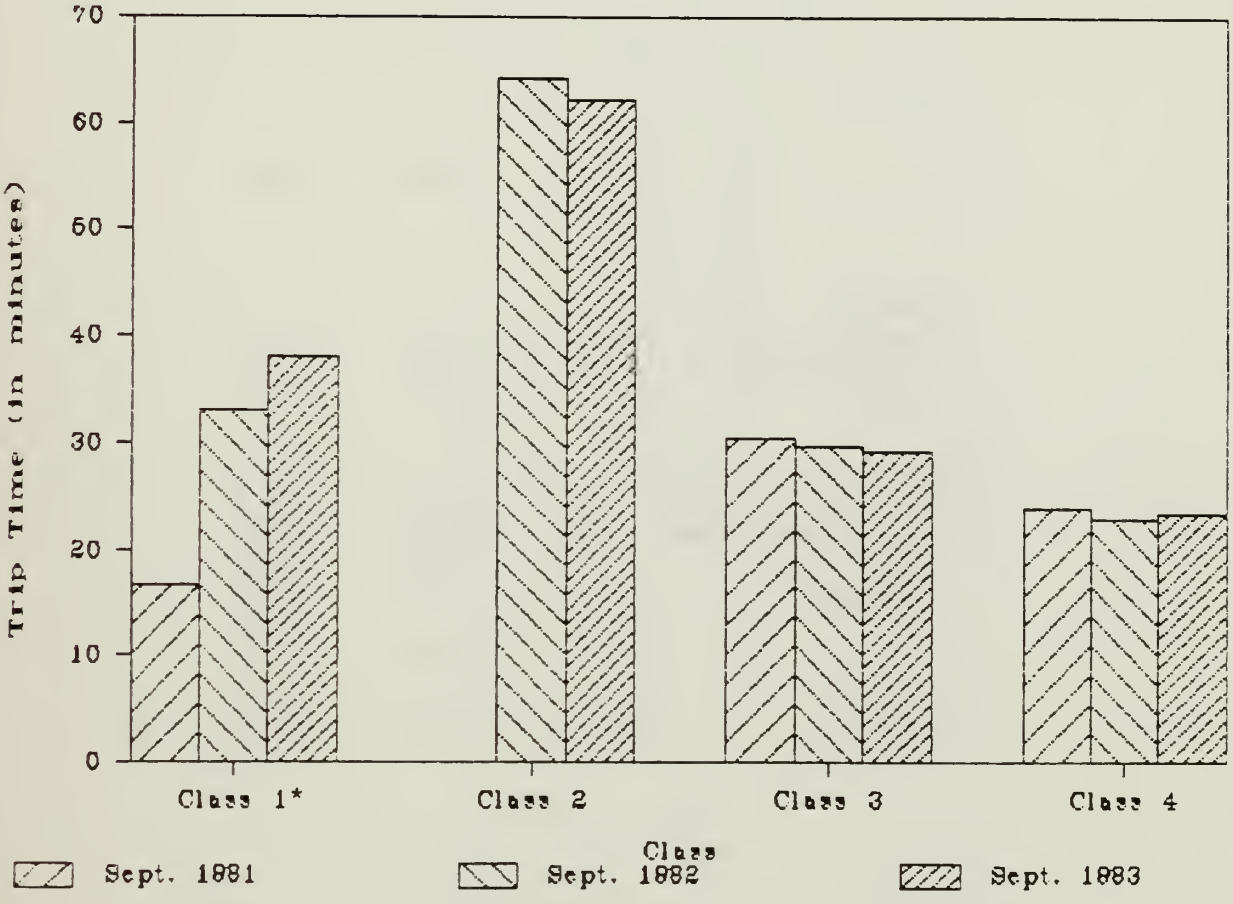
CLASS 4 Purpose	1981	1982	1983
Medical	152	119	171
Employment	211	209	277
Social	142	145	155
Education	83	84	81
Other	30	20	45

*Note:
1982 and 1983 Class 3 trips represent net trips, i.e. 1982 and 1983 Class 2 trips, respectively, have been subtracted from total Class 3 trips to compensate for the double counting on Class 2 trips.

Special-Needs Transportation Evaluation Technical Report 53a September 1985	DISTRIBUTION OF TRIPS BY TRIP PURPOSE BY YEAR	CTPS TABLE E-1

APPENDIX F

TRIP TIME BY TRIP ORIGIN-DESTINATION CHARACTERISTICS



*Class 1 includes waiting time for 1982 and 1983.

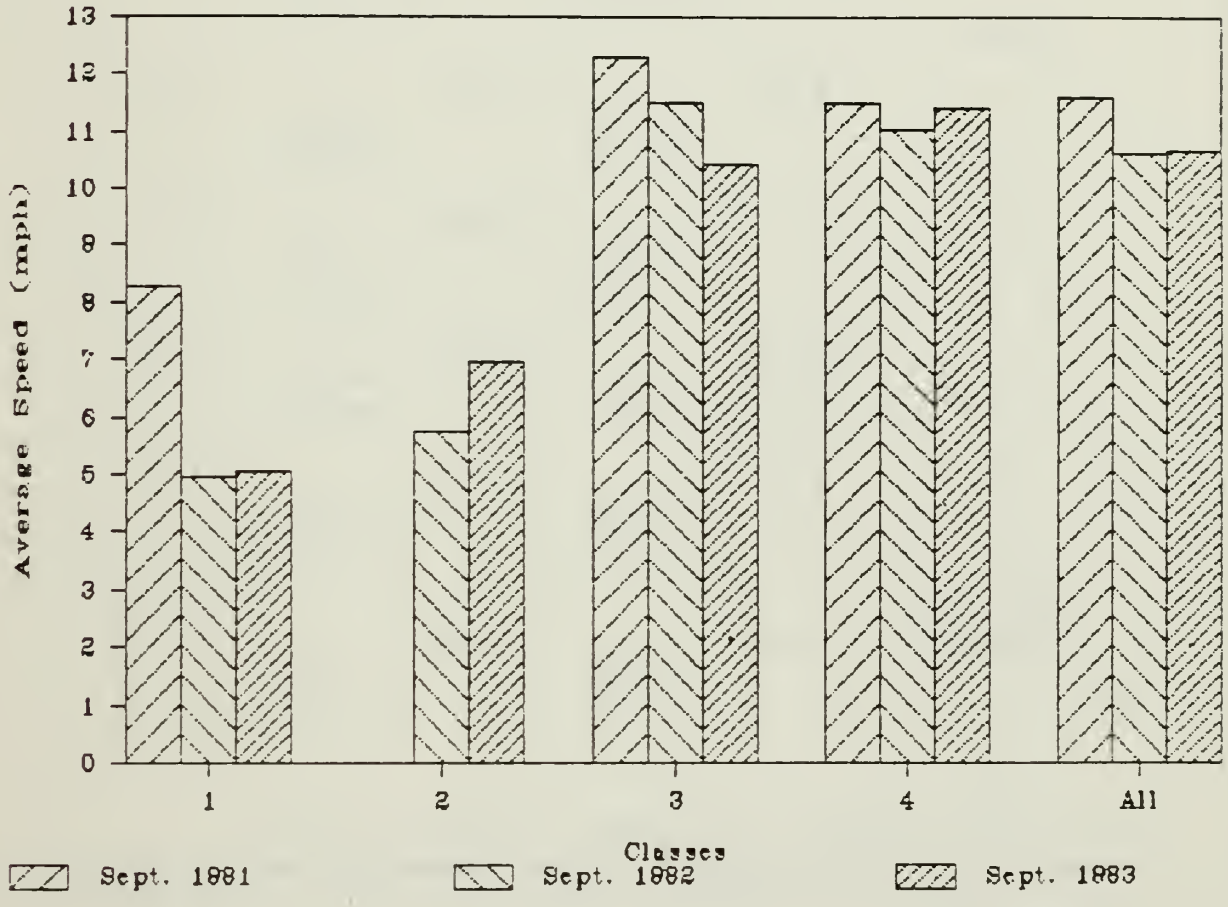
Special-Needs Transportation Evaluation	AVERAGE TRIP TIME	CTPS
Technical Report 53a September 1985		FIGURE F-1

	1981	1982	1983
Class 1			
Travel Time	16.7	17.9	22.9
Wait Time	0	15	15
Total	16.7	32.9	37.9
Class 2			
Dmtn Trvl Time	0	19.5	18.2
NonD Trvl Time	0	29.8	29.1
Wait Time	0	15	15
Total	0	64.3	62.3
Class 3	30.5	29.8	29.1
Class 4	23.9	22.8	23.4

Special-Needs Transporation Evaluation	AVERAGE TRIP TIME (IN MINUTES) FOR ALL TRIPS BY CLASS AND BY YEAR	CTPS
Technical Report 53a September 1985		TABLE F-1

APPENDIX G

TRIP SPEED BY TRIP ORIGIN-DESTINATION CHARACTERISTICS



Special-Needs Transportation Evaluation Technical Report 53a September 1985	AVERAGE TRIP SPEED (From Completed Trip Data)	CTPS FIGURE G-1

Class	Sept. 1981	Change (%)	Sept. 1982	Change (%)	Sept. 1983
1	8.27		4.94		5.03
		-3.33		0.09	
		-40.2		1.821	
2	0		5.75		6.95
		5.75		1.2	
		ERR		20.86	
3	12.28		11.48		10.42
		-0.8		-1.06	
		-6.51		-9.23	
4	11.5		11.02		11.41
		-0.48		0.39	
		-4.17		3.539	
Avg. All Classes	11.6		10.62		10.68
		-0.98		0.06	
		-8.44		0.564	

3*

In the above table, the number of Class 3 trips represents the old Class 3 trips, Class 3*, minus the old Class trips, to compensate for the double-counting of linked trips in Class 3*.

Special-Needs Transportation Evaluation	AVERAGE TRIP SPEED (FROM DATA ON COMPLETED TRIPS) BY YEAR AND CHANGES BETWEEN YEARS	CTPS
Technical Report 53a September 1985		TABLE G-1

APPENDIX H

DATA USED IN CALCULATING VEHICLE SPEED

NOTE

As discussed in chapter 5, a sampling of passenger logs from Distributor vehicles indicated that certain vehicles stopped for prolonged periods when they were scheduled to be on tour. The vehicle speed for these vehicles was appreciably lower than the average vehicle speed of all Distributor vehicles. If Distributor vehicles had always adhered to their appointed schedules, average vehicle speed for the Distributor would have been improved marginally.

Date	Vehicle No.	Start Time	Start Mile	End Time	End Mile	Total Time	Total Mile	Average Speed	Tot Time (decimal)
Sept 20 1982	96	6:45	988	18:00	1048	11:15	60	5.333333	11.25
Sept 20 1982	97	7:05	892	16:20	943	9:15	51	5.513513	9.25
Sept 21 1982	95	7:00	311	17:35	369	10:35	58	5.480487	10.583
Sept 21 1982	96	6:45	56	17:55	117	11:10	61	5.462523	11.167
Sept 22 1982 **	95	7:00	417	17:25	464	10:25	47	4.511855	10.417
Sept 22 1982	97	6:45	39	12:50	68	6:05	29	4.767384	6.083
Sept 23 1982	96	6:45	125	18:00	409	11:15	53 *	4.711111	11.25
Sept 23 1982	97	7:00	965	17:55	1024	10:55	59	5.404415	10.917
Sept 24 1982	95	7:00	478	18:05	533	11:05	55	4.962585	11.083
Sept 24 1982	96	7:15	161	18:00	218	10:45	57	5.302325	10.75
TOTAL							530	5.158150	102.75
Sept 19 1983	24	7:10	552	17:30	600	10:20	48	4.645311	10.333
Sept 19 1983	25	7:05	745	17:40	788	10:35	43	4.063120	10.583
Sept 20 1983 **	97	7:10	336	17:00	375	9:50	39	3.966236	9.833
Sept 20 1983	98	7:00	309	17:30	361	10:30	52	4.952380	10.5
Sept 21 1983	29	7:10	113	17:20	161	10:10	48	4.721156	10.167
Sept 21 1983	98	7:00	877	17:30	931	10:30	54	5.142857	10.5
Sept 22 1983	97	7:10	339	17:30	378	10:20	39	3.774315	10.333
Sept 22 1983 **	98	7:00	366	15:50	399	8:50	33	3.735990	8.833
Sept 23 1983 **	11	7:10	387	16:20	420	9:10	33	3.599869	9.167
Sept 23 1983	98	7:00	74	16:40	120	9:40	46	4.758456	9.667
TOTAL							435	4.353657	99.916

* This mileage figure was manually calculated, because two vehicles were used to serve this particular route on this date.

** The double asterisk indicates that for these vehicles on these days the odometer readings (in some instances, at least) between timed observations appear to be unreasonably low.

Special-Needs Transportation Evaluation Technical Report 53a September 1985	DATA FOR THE CALCULATION OF AVERAGE VEHICLE SPEED ON VEHICLES USED FOR OPERATING THE DOWNTOWN DISTRIBUTOR	CTPS TABLE H-1

DATE	Vehicle No.	START Time	START Mile	END Time	END Mile	TOTAL Time	TOTAL Mile		Average Speed	Tot Time (decimal)
Sept 20 1982	96	6:45	988	18:00	1048	11:15	60		5.333333	11.25
Sept 20 1982	97	7:05	892	16:20	943	9:15	51		5.513513	9.25
Sept 21 1982	95	7:00	311	17:35	369	10:35	58		5.480487	10.583
Sept 21 1982	96	6:45	56	17:55	117	11:10	61		5.462523	11.167
Sept 22 1982	97	6:45	39	12:50	68	6:05	29		4.767384	6.083
Sept 23 1982	96	6:45	125	18:00	409	11:15	53	*	4.711111	11.25
Sept 23 1982	97	7:00	965	17:55	1024	10:55	59		5.404415	10.917
Sept 24 1982	95	7:00	478	18:05	533	11:05	55		4.962555	11.083
Sept 24 1982	96	7:15	161	18:00	218	10:45	57		5.302325	10.75
TOTAL							483		5.231065	92.333
Sept 19 1983	24	7:10	552	17:30	600	10:20	48		4.645311	10.333
Sept 19 1983	25	7:05	745	17:40	788	10:35	43		4.063120	10.583
Sept 20 1983	98	7:00	309	17:30	361	10:30	52		4.952380	10.5
Sept 21 1983	29	7:10	113	17:20	161	10:10	48		4.721156	10.167
Sept 21 1983	98	7:00	877	17:30	931	10:30	54		5.142857	10.5
Sept 22 1983	97	7:10	339	17:30	378	10:20	39		3.774315	10.333
Sept 23 1983	98	7:00	74	16:40	120	9:40	46		4.758456	9.667
TOTAL							330		4.578055	72.083

* This mileage figure was manually calculated, because two vehicles were used to serve this particular route on this date.

Special-Needs Transportation Evaluation Technical Report 53a September 1985	DATA FOR THE CALCULATION OF AVERAGE VEHICLE SPEED ON VEHICLES USED FOR OPERATING THE DOWNTOWN DISTRIBUTOR ELIMINATING THE RECORDS FOR VEHICLES WITH THE LOWEST VEHICLE SPEEDS	CTPS TABLE H-2